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# A 1980's VIEW OF WATER MANAGEMENT IN THE POTOMAC RIVER BASIN

COMPLETED

NATIONAL CAPITAL SECTION
AMERICAN WATER RESOURCES ASSOCIATION

A REPORT

FOR THE

SUBCOMMITTEE ON GOVERNMENTAL EFFICIENCY AND THE DISTRICT OF COLUMBIA

OF THE

COMMITTEE ON GOVERNMENTAL AFFAIRS,
UNITED STATES SENATE

NOVEMBER 12, 1981

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## LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON GOVERNMENTAL AFFAIRS,
SUBCOMMITTEE ON GOVERNMENTAL EFFICIENCY
AND THE DISTRICT OF COLUMBIA,
*Washington, D.C., May 28, 1982.*

Hon. WILLIAM ROTH,
*Chairman, Committee on Governmental Affairs,*
*U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: The Subcommittee on Governmental Efficiency and the District of Columbia has had an ongoing interest in the Potomac River Basin and its significance as a precious natural resource. Preservation and enhancement of this resource is a subject of national concern, and provides a precedent from which other river basins can learn.

In this regard, several years ago the Subcommittee requested the Congressional Research Service of the Library of Congress to undertake a comprehensive study of the Potomac River Basin, including its history and its future. To date, several works prepared by and for the CRS have been published by the Governmental Affairs Committee for use in the continuing work on this subject.

Today I am sending another work for publication consisting of the proceedings of a seminar entitled "A 1980's View of Water Management in the Potomac River Basin." Clearly, competent and enlightened water management is essential to the future health of the Basin. The seminar brought together a group of professionals with a common interest in the preservation and enhancement of the Potomac River Basin, and resulted in an excellent series of papers which are included in this work.

The publication of the proceedings of this important one-day seminar would further the work of both the Subcommittee and the Congressional Research Service in studying the Potomac River Basin. I therefore respectfully request that the Committee on Governmental Affairs issue the proceedings as a committee print for the use of the Subcommittee and others interested in the Basin.

With best wishes,

Sincerely,

CHARLES MCC. MATHIAS, JR.,
*Chairman.*

## PLANNING COMMITTEE

In the Summer of 1981, the Executive Board of the National Capitol Section of the American Water Resources Association concluded that recent developments in water supply management in the Washington Metropolitan Area warranted holding a day-long seminar. The purpose was to highlight these cooperative and innovative efforts and to display them in the context of what had gone before. Furthermore, it was believed that the benefits of the proposed meeting should be extended by compiling a proceedings to document this timely accounting of cooperation among the principal water agencies in the Basin.

To organize the seminar and guide its recording, a seminar planning committee was formed. Dr. Warren Viessman, Jr. of the Congressional Research Service was named Chairman of the Committee and Chairman of the Seminar. The members of the Committee were: James E. Crews, U.S. Army Corps of Engineers, Institute for Water Resources; Mark V. Huges, Jr., Consultant; Kyle Schilling, U.S. Army Corps of Engineers, Institute for Water Resources; Paul Eastman, Executive Director, Interstate Commission on the Potomac River Basin.

ACKNOWLEDGEMENTS

The Planning Committee for the Potomac River Seminar sponsored by the National Capitol Section of the American Water Resources Association greatly appreciates the interest in the seminar shown by Members of the United States Congress. In particular, the Committee would like to thank Senator Charles McC. Mathias Jr., Chairman of the Subcommittee on Governmental Efficiency and the District of Columbia, for his support of this undertaking. The Committee would also like to express its thanks to James E. Crews who edited the proceedings and to Cindy Merrill for typing the manuscript.

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# A 1980's VIEW OF WATER MANAGEMENT IN THE POTOMAC RIVER BASIN

by

Warren Viessman, Jr.

## PREFACE

Since the early 1600s when man first settled in the Potomac River Basin, there has been a continuing concern with the river and its use. For about the first two hundred years, this focus was mainly on transportation and communication. Following that era of early western movement, attention shifted to issues surrounding water supply, and later pollution control. The generator for this shift was the ever-increasing population in the basin, especially in the Washington Metropolitan Area.

Shortly after the turn of the century, water planning of various sorts became commonplace and intense. Hundreds of studies emerged, some by the U.S. Army Corps of Engineers, others by State and local levels of government. Perhaps unfortunately, perhaps not, most of these plans became library show pieces rather than blueprints for action. The reasons for this have been many, but a principal determining factor has been the fractured fabric of institutions having influence over decisions about water management in the basin. Dr. Abel Wolman has aptly put it... "An orderly management of the array of functions... is distinguished by its absence. That it is needed has generally been agreed upon... [but]... Suspicion of an overlying authority, by whatever name, has characterized public and private reactions."

Institutional tug-of-war well describes most attempts to implement proposals for Potomac River Basin development and/or management. The result has been a general stagnation of effort. But concurrent with this inactivity was the building of pressure to "do something" as the metropolitan area population grew and periodic low-flows in the river became more troublesome. It is axiomatic that crisis generates action, and this is also true for the Potomac.

What has occurred since the late 1970s has been a unique amalgam of institutional cooperation and technological expertise. The Corps of Engineers, the States of Maryland and Virginia, the Interstate Commission on the Potomac River Basin, the Fairfax County Water Authority, the Washington Suburban Sanitary Commission, the

Metropolitan Washington Area Council of Governments, and other key actors worked hard and diligently to provide a setting for coordination of river management policies that would work to the benefit of all. An exercise in mutual cooperation was complimented by a fresh new technical approach to solving the Potomac's water supply problems. The direction taken was that of improved systems management rather than structural development (the old Nemesis).

This existing coalescence of ideas and cooperation marks a new era for water management in the Potomac River Basin. Beyond that, it serves as a model for what may be the new wave elsewhere. All of the old constraints are not lifted, but there is no denying that the once stagnant pond has been converted to a dynamic water course. This seminar tells the story of how all of this came about and what it portends for the future. It is an exciting and timely story, one which has great implications for areas far from the shores of the Potomac.

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# INTRODUCTION

BY

GILBERT GUDE

When Bud Viessman first asked me to participate in your 1980 View of Water Management in the Potomac River Basin Seminar, I was indeed pleased. Bud and I joined the Congressional Research Service at almost the same time. He came to CRS as Senior Specialist in Engineering and Public Works from a long and distinguished career of teaching and of research management in the field of water resources. He has served from New Mexico to Maine, to Nebraska, but more importantly, his launching pad -- and his heart and soul I believe -- are still at Johns Hopkins University.

As I looked at the carefully planned program which will give a comprehensive overview of the Potomac's complex water management problems, I was delighted to see that Professor Emeritus Abel Wolman would give us a perspective in time -- an historical overview. Dr. Wolman is not only Professor Emeritus at Hopkins, but his vision of experience and wisdom makes him in the larger sense Professor Emeritus internationally among the small group of scientists who have a good understanding of world water resource problems today.

It is essential to have an historical perspective of water management in the Potomac Basin if decisions and actions are to approach a congruence with the needs of people throughout the Basin. For one thing, it reinforces appreciation of how continually evolving technologies can alter both the problems and the ways with which we should deal with them. At this very moment new technologies are altering the parameters of problems and plans. Within a year -- to maintain the closest possible congruence to need -- we could well modify today's game plan for any one particular project.

Although the topics on today's program do not necessarily involve the entire Potomac watershed region, each pertains to a regional approach in assessing or dealing with some aspect of Potomac water management.

There is nearly always some concern about governmental activity in areas that extend over political subdivisions; but regional approaches have been part of Potomac history for more than three and

a half centuries. Now our researchers at the Library of Congress have not yet ascertained all the facts, but it seems evident from my studies that the Solons of the Five Nations Indian Tribes in the Great Lakes Region adjusted their policies regarding military and trade activities to conform to the geography of the Potomac Basin.

The first definitive statement directed to planning which would utilize the Potomac as a regional unit was the instruction to Captain John Smith in the early 1600's: that he, in his exploration of what we today know as the Potomac, was to "find some spring which runs contrary way towards the East Indian Sea." John Smith was obedient to his orders and in 1608 -- while making cursory observations of other parts of the Chesapeake Bay region -- he made thorough and detailed explorations of the Potomac.

For two centuries interest in the River and its tributaries as a regional unit focused almost exclusively on its usage as a transportation and communication link between the East Coast and the transmontane: Washington's epic explorations; his founding of the Potomac Canal Co.; and its evolution into the C & O Canal. Private institutions and government were preoccupied with utilizing the River itself as a means of efficient transportation. And as we all know, the technology of the railroad finally ruled out the Potomac River as a transportation artery. But the idea died hard: it was early 1930s that the Corps of Engineers issued what was possibly the last hurrah for a Potomac navigation system when they outlined a scheme for barges and boats to travel up the Potomac and through the great Backbone Mountain, to the Youghiogheny, the Ohio, and finally into the Mississippi. The 1930 plan was a massive scheme: a 12-ft. channel, 27 dams and a 2-mile long tunnel through the Great Backbone Mountain -- and there was to be a bonus production of a billion kilowatts of prime energy!

Dr. Wolman has told us of the rise of the second area dealt with in the Basin: water resources. This, too, was a regional question. Washington's need for potable water to avoid the pestilences -- typhoid and cholera -- Montgomery Meigs regional water supply system from Great Falls. While hope for a Potomac Basin transportation route faded away, the water supply aspects of the River came to full flower: the 1941 establishment of the Interstate Commission to abate pollution; the 1950 Ten Rivers Report of the Corps; and the mammoth 1963 Corps Basin Report with a vast system of reservoir and impoundments as a means of water management.

While regional water management preoccupied much of the early Twentieth Century, some began to look at the Potomac Basin as a unit through which other goals could be achieved. Legislation to establish the C & O Canal Historical Park first introduced in the 1950's was, in fact, a regional initiative. The 1968 Nations River Report addressed water supply, erosion and sediment problems, but preservations and enhancement of the landscape and recreation were very much part of this plan. In 1970 concern about the Fed's motivation by some, and

about Federal inability to deal with Potomac problems by others, led to amendments of the Interstate Commission's Charter. As we know, the Compact was broadened to responsibilities beyond water pollution abatement but was stopped short of being granted planning regulatory powers.

As we look at the total story of the Potomac Basin we should keep two significant points in mind. Explorers, planners, and private and public institutions have always looked at large parts of the River as units in order to achieve certain goals, and individual plans and programs over time have dealt progressively with more than one goal. We now have on-going regional efforts in water management, pollution abatement, land transportation systems, recreation, landscaping enhancements, and historical preservation -- and some of these efforts are closely tied together.

It is always tempting when we plan, to tie all of the objectives together and as some like to say -- with one of today's favorite terms -- use a holistic approach. Developing "the total plan" -- putting all our eggs in one basket -- could well lead to the worst kind of bureaucratic omelet. And even before we would be able to get our "holistic omelet" on the stove, some of the eggs could well spoil. But there are some goals and objectives which can be combined; flexibility and resilience in planning are important -- keeping an open mind as to what other objectives might be accomplished by some alterations of a particular plan can enhance our efforts.

And speaking of resilience and flexibility, it is imperative to keep well apprised of evolving technology. For example, breakthroughs in water treatment technology mean that recycling water from the estuary is no longer a silly environmental idea of a few years ago but a very workable scheme. And remember how medical and water testing technology changed our whole view of chlorine as a water treatment material? And a development in agriculture technology is raising lots of new questions in my mind, and I know in the minds of all hydrologists, whether they are looking at the Potomac Basin or any other River Basin in the United States. No-till cultivation is significantly reducing erosion, and water run-off from farmland. Fortunately, preliminary data seem to indicate that the weed killers used in this practice break down so rapidly that they will not create a problem for aquatic flora. This development could be the environmental news of the decade -- even the century. Sediment and water run-off, which started when Maryland and Virginia were the Bread Basket of the Revolution, could become problems of the past. How much of the Potomac's hydrological flow in our Potomac region will be augmented through increased ground water and flow from springs which went dry decades -- even centuries -- ago?

The very format of today's program seems to me to augur well for thoughtful planning and action -- taking the large view of the Potomac Basin and remaining flexible so we can adjust to our fast moving

technologies; we can keep in mind that there was a unity to the River as Captain John Smith saw it -- just as there is a unity in the Potomac Basin pictures of the astronauts.

**KEYNOTE ADDRESS:**

**The Potomac River Revisited for the Nth Time**

by

Abel Wolman

My program assignment is far more pretentious than I dare to cover. A benevolent assignment to the aged invariably is to look backward. The implications in the title, "A Historical Perspective of Water Resources Development in the Potomac River Basin," moves me to a more modest revisiting of the Nation's River - legitimately named but still an orphan resource.

When I last took a look[1] at the Basin in 1976 it was at a session in Arlington somewhat similar to the present one, devoted to another detailed scrutiny. In opening that one I ventured to suggest that "detailed scrutiny had been its fate for most of its recent 200 year history. The last 100 years witnessed more detailed examination of this great and patient river, due to the advent of the bacteriological era. The famous Theobald Smith initiated this new scientific review of the River in 1886. For almost a century thereafter, up to yesterday, the Potomac Basin has been in the diagnostic clinic practically without interruption. The physicians in attendance have represented every Federal, State and local official agency and, in the last decades, virtually every citizen group militant and vocal enough to be admitted into the intensive care unit.

In this century of study, restudy, conference, and legislative hearings, tens of thousands of printed pages, resting upon shelves of libraries, have emerged. All of them have contributed data and words of wisdom. One of the last of these, for the moment, are the refreshing realistic and earthy document called "Dollars and Sense," the remarkably informative Report on the Northeastern United States Water Supply for the Washington Metropolitan Area and the recent Pre-Conference Report Toward a Potomac Action Strategy. They represent the continuing diagnostic exercises to which the patient has long been exposed.

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[1]Abel Wolman. The Potomac River Revisited. Potomac Conference, Arlington, Virginia, November 4, 1976.



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Chronological listings of official and unofficial clinical observations during several centuries are as familiar to you as they are to me. They will not be repeated here ad infinitum. Some of their findings appear in the stock-taking you expect of me. My own participation in diagnostic endeavors began almost seventy years ago. They have been pursued almost without interruption from then until now. Throughout that period I joined everybody who sought therapy for the ills of this majestic river.

Throughout that period it was clear that the only constant was change. All parameters were undergoing modification even while each inquiry was under way, with one important exception. Hydrologically, the River was constant, as it has been for millenia. Only the layman is surprised or even mystified by recurrent droughts, floods, and contamination by man and nature. Essentially, the other variabilities were inherent in the increasing presence of man and his doings. The problems thus became those of human behavior vis-a-vis the physical, chemical and biological management of the River itself. The millions of dollars spent on these investigations have never been totaled. I have tried to get such a figure with no success. It is undoubtedly large.

Within this setting, where are we now and, more important, where do we hope to be tomorrow? An attempt at such an analysis is restricted, in the interest of both time and practicability, to a few insignificant categories. These I examine in limited detail.

## RESOURCES AND QUALITY

The River has potential values, and consequent problems, in water supply, recreation, hydropower, fisheries, flood control, low flow regulation, waste water reception, and aesthetic adjustment. Confronted with this array of often competitive functions, the century record discloses an astonishing assembly of shifting government policy, fiscal inadequacy, agency battles for position, private versus public interests, eternal variations in regulatory demands, and hopes for the emergence of novel, simplistic technologic solutions. Implicit in the scene is the tacit assumption that time alone somehow will resolve all issues!

The conclusion that the future will provide the key to the best utilization of the River has not yet been validated. As was pointed out in the 1968 Report of the Department of the Interior, it is still true in 1981 that:

"If the Potomac has been much studied, it has nevertheless been subjected to only meager 'development' over the centuries of its service to civilized men. Most past attempts to alter it significantly

for man's use have either failed or have not led to lasting results, though their changing purposes over the years summarize, to a degree, America's shifting attitudes toward the utility of flowing water."[2]

Practitioners in this game have taken refuge in grand generalizations regarding maximum beneficial use of the resources. The desire for total logic has sometimes stood in the way of more modest "doable" actions. In spite of these multiple constraints, some things were done. The River today is in good shape in the bulk of its course. Even in the Washington Metropolitan Area, the prospect of improved quality is around the corner, though major problems of sewage sludge disposal remain to plague us. In that same vicinity of the Capitol, water quality for swimming is in fact at hand. Public acknowledgement of that reality, for strange reasons, is muted. Aesthetically, the River by and large is attrative. Fish are now survivors, rather than relics of bygone days.

The problem of soil loss and accumulation of sediment remains unresolved -- a victim of less than intelligent land management. Speeding up this corrective requires an unusually high degree of optimism.

Whether hydro-power may be recaptured is debatable, even in the present climate of the energy crunch. The forces which historically prevented its development may by no means be moribund.

As to water supply, later discussion hardly suggests that its logical development has been assured. Dramatic battles remain to be fought and adjudicated.

## MANAGEMENT

An orderly management of the array of functions here delineated is distinguished by its absence. That it is needed has been generally agreed upon by most students of the basin. Hostility to such an institutional device had always been vocal, and in course of time, became more and more vociferous. Suspicion of an overlying authority, by whatever name, has characterized public and private reactions.

Logic would be served, at least theoretically, if an appropriate hierarchy existed to plan and execute a wise functional program. In our political system, logic has usually been in short supply.

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[2]The Nation's River. The Department of the Interior Official Report on the Potomac. October, 1968.

Hartley described last year the structural morass in planning which confronts us.[3] We tend to forget that "we have a remarkably fragmented system of divided powers ... State, Federal and local ... and legislative, executive and judicial." All have a hand in the planning exercise, with one partner which usually has all the money, the Federal Government. The Capitol of the greatest country in the world sits in the middle of all this arena.

If we needed more evidence as to how not to resolve important issues, Hartley helps us by listing, aside from the political entities of four States and the District of Columbia, nine State planning and budget offices in the Potomac Region. Guarantees are further provided to continue confusion in decision-making by the existence of 647 subsidiary planning units in this same region.

I cannot list all the devices, over time, which have been created to escape from this startling machinery. Many have been devised by the Federal Government. Virtually, all have failed. We now have a diagnostic volume on perhaps the most long-lived group - the National Resources Planning Board. As those things go, the Board had a miraculous life of more than ten years. Its deliberate destruction by Congress is now reviewed in the recent volume[4] by Marion Clawson. I commend it strongly for your careful reading as it sheds light upon our dilemma in moving toward orderly development.

Other approaches are familiar to you. The Interstate Commission on the Potomac River Basin and various area councils of government were designed to be surrogates for a central basin agency. They have done well, but not well enough. They are blocked by designedly limited powers. The result is progress, but not the elimination or compromise of competitive interests. These latter have grown in number and in decibels.

## PUBLIC PARTICIPATION

The phenomenon of public participation is old, but the last ten to fifteen years have multiplied its numbers and fervor to an astonishing degree. Hostility is not a recent invention. In the 1913's, the Trustees of the Board of the Miami Conservancy District

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[3]David K. Hartley. Regional Planning: The Potomac Experience. Publ. The Government Division of the Library of Congress. August 26, 1980.

[4]Marion Clawson. New Deal Planning: The National Resources Planning Board. Resources for the Future, Washington, D.C. 1981.

were stoned at their meetings for suggesting the creation of the Greater Miami River flood control authority. That device was opposed as socialistic and a plot of the Communist Party. That the agency was created and still functions successfully is a tribute to the courage and wisdom of its creators.

We have always sought the help of an understanding citizenry. But we have paid a dear price for the dramatic and pervasive explosion of public participation. My guess is that proliferation of the communication media generated the present paraders. Within hours after the Three Mile Island event, I watched on television thousands of militant marchers in West Germany. The spectacle of this extraordinary communicable disease of hysteria is relevant to an assessment of its impact upon Potomac River activities.

The consequences of a militant and too often uninformed group of protestors are apparent in a number of bandwagon slogans. Some of these are the familiar demands for universal curtailment of water use, the emphasis of non-structural solutions to the necessity of water availability, the generation of selfish local principalities, and the consequent development of negativism and delay.

The impact of these philosophical attitudes upon river development are not restricted to the Potomac basin. The history of this basin reveals however the damage imposed by the banners raised in the last decade.

Henry J. Graeser[5] has provided recently a thoughtful review of the impact of the conservation ethic upon water service. Without belaboring the issue, Graeser points out that "Reasonable measures to remind us of a need to conserve make sense." But "We border on hypocrisy and deceit when some of the measures are presented as panaceas and an integral part of our national water policy rather than a means of creating awareness."

Recent droughts here and in western Europe are sharp reminders that "Capital investment in water facilities must be completed and available if we are to offer safe and reliable water service under all climatic conditions. Little capital can be saved through the installation of water savings devices in the home."[6]

Officials in England commented upon their recent severe drought experience by blessing their forebears who had provided impoundments which alleviated effects of dry periods. They warned that at the next drought those water bank accounts will have been exhausted, unless additional storage is soon provided.

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[5]Henry J. Graeser. The Conservation Ethic. Unpublished document. October 30, 1980.

[6]Ibid.

The present enthusiasm of both the layman and the professional to postpone difficult decisions creates long-term disabilities. This is particularly evident in the field of energy development, in which the water industry has a stake. In the two collateral fields procrastination has assumed a cloak of virtue. The result in fact has been truly a paralysis by analysis, from which we have not yet escaped.

What has all this done to the diligent practitioner? When one reviews the record we can be pleased that the River shows much quality improvement, public understanding is hopefully greater, and management on a broad scale is not available. Purveyors are moving slowly toward cooperative action.

Perhaps the greatest accomplishment lies in the remarkable development of the tools of diagnosis and evaluation. The joint use of computer and system analysis permits prompt and profound assessments of multiple choices of action. A major accomplishment by this methodology is in the remarkable revolution in the approach to drought management. Dan Sheer, R.M. Hirsch, J. Smith, J. Schaake and their associates well deserve an encomium upon the creation of a procedure to equate human behavior vis a vis hydrologic variability.[7]

So far, analytic and predictive methodologies have out stripped implementation of expanded service facilities. Equilibrium of these forces reacts upon the next hydrologic catastrophe.

I am apologetic that I must close these remarks on a darker note in contrast with the listing of accomplishments. The climate of public participation, often by vocal and misinformed minorities, has had unfortunate effects upon the approach to technical solutions. The scientist and technologist have always prided themselves on their objectivity in attacking a problem. That objectivity has been slowly eroded in this as well as in other river basins. As one examines the long continuum of reports, it is increasingly clear that the authors gradually and not too subtly succumb to appeasement to external pressures, not because of conviction, but because it is easier to do so. In fact, one can discern a long, evolving manifestation of intimidation of professional objectivity. The phenomenon has been enhanced by the easy flow of government largesse. This money drought is now at hand and, as droughts often do, it may force us to return to logic, wisdom, and sanity in diagnosis, assessment, and implementation. Until that day arrives, the successful development of necessary works in the Potomac Basin will remain sadly in arrears. I certainly hold no brief for consistency, but premonition must have prompted me to say 25 years ago: "It is difficult to escape a kind of cynicism about the federal grants-in-aid if you live long enough. --- I would have to be shown first that there is a necessity."[8]

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[7]Daniel P. Sheer. Analyzing the Risk of Drought. JAWWA, May 1980.

[8]I.C.P.R.B. Newsletter, Vol. 12, No. 6, June, 1956, p. 4.

One may hope for a return to that democratic process in which the sovereign power rests in an informed people and is exercised for them by the officers elected by them. In that realm, professionals may yet recapture their role as providers of objective analysis, to permit wise value judgments by the elected official, acceptable to the general public. It should mark an end to postponing hard decisions and relegating them to posterity. We have been seduced by a philosophy of do nothing, under the guise of an ecologic ethic, aided and abetted by the virtual disappearance of mutual concern.

# BLOOMINGTON LAKE REFORMULATION STUDY

by

James W. Dunmyer

The Bloomington Lake Project is located on the North Branch Potomac River about 8 miles upstream from the confluence of Savage River at Bloomington. The project lies in both Garrett County, Maryland, and Mineral County, West Virginia.

From its source to the dam site, the North Branch descends about 2,000 feet in a distance of 36 miles. The watershed above the dam has a roughly rectangular drainage area of 263 square miles that is 23 miles long, and 12 miles wide. The watershed contains no natural lakes and a few small marshy areas. Since stream slopes are steep and the valleys are narrow, valley storage of flood waters is small.

The Reformulation Study of Bloomington Lake was initiated in October 1978 and is being conducted as an integral part of the ongoing Metropolitan Washington Area (MWA) Water Supply Study. The MWA Water Supply Study was authorized by the Congress in Section 85 of the Water Resources Development Act of 1974.

The Act authorized a complete investigation of the future water resource needs of the MWA. This Act also authorized construction of a Pilot Estuary Water Treatment Plant, a topic Mr. Ways will address later this morning, and further directed that the entire study be reviewed by the National Academy of Sciences and the National Academy of Engineering.

The overall objective of the MWA Water Supply Study is to examine the water supply problems in the MWA and to develop alternatives for meeting existing and future needs.

Within that study, the overall objective of the Reformulation Study is to assess the potential of the Bloomington Lake Project to meet a portion of the growing MWA water supply demands.

The reasons for the Reformulation Study are three-fold:

(1) The preliminary results of the ongoing MWA study indicate that the MWA could have water supply shortages in the years ahead and that presently developed water supply resources in the area would not be sufficient to alleviate those projected shortages.

(2) In April 1978, five MWA Congressional Representatives (Harris, Fisher, Spellman, Steers, and Fauntroy) requested through the House Public Works and Transportation Committee, that a restudy of Bloomington Lake be undertaken. Other agencies such as the Interstate Commission on the Potomac River Basin also supported the investigation of the full water supply potential of the project.

(3) During the years 1977-1978, two independent evaluations were made to assess the water supply potential of Bloomington Lake. The results of the preliminary analysis made by the Corps of Engineers indicated that some flood control storage could be reallocated to water supply storage and this additional water supply storage could be used effectively to meet MWA water needs without adversely affecting the degree of downstream protection.

The other evaluation made by the Johns Hopkins University concluded that combined operation of the four reservoirs (Bloomington, Savage, Occoquan, and Patuxent) as an integrated system could furnish significantly more water during a drought than if each reservoir were operated independently.

Simply stated, the objectives of the Bloomington Lake Reformulation Study are:

(1) To investigate the full water supply capability of the presently authorized low flow augmentation (water supply and water quality) storage by identifying optimum release rules for a specific set of hydrologic and demand conditions;

(2) To determine the feasibility of reallocating the water quality storage and/or some of the flood control storage to water supply storage to furnish additional downstream water supply.

I should emphasize here that we intend to initially investigate fully the water supply potential of the project as authorized by the U.S. Congress without encroachment of any other project use. This investigation will fully consider the engineering, socio-economic, and environmental impacts which might result from development of different operating rules. The second part of these analyses will assess the feasibility of reallocation of flood control storage to water supply storage. Simply stated, what we intend to do is to find out if by changing the operating rules we can improve the Potomac flow at Washington, D.C. If not, can a portion of the project storage be reallocated without adversely affecting the downstream water quality, the project area environment, and the degree of downstream flood protection.

The project was authorized by the Flood Control Act of 1962 (Public Law 874) for flood control, municipal and industrial water supply, water quality control, and recreation. This authorization



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required a non-federal interest to agree to repay all costs allocated to water supply amounting to 33.2 percent of the total construction cost which is currently estimated to be $174,300,(J0. The project controls 263 square miles of drainage area or about 20 percent of the drainage area of the North Branch Potomac River. The project's authorized storage as allocated is 92,000 acre-feet for low flow augmentation (water supply (41,000) and water quality (51,000)) and recreation, and 36,200 acre-feet for flood control (2.58 inches of flood runoff).

Including design surcharge and freeboard storage, the total storage capacity of the project to the top of the dam will be 148,200 acre-feet. I might add here that during the winter and spring months, the project will provide 80,600 acre-feet of flood control storage when the conservation pool is drawndown to accommodate larger winter flood runoffs.

The project includes a rolled earth and rockfill enbankment approximately 296 feet high and an earth and random fill dike about 90 feet high in an adjacent saddle.

The project also includes a controlled outlet works consisting of an intake tower, with intake ports are various elevations, service bridge, and a 1,600-foot concrete lined tunnel.

Lastly, the project includes recreational facilities; relocation of the Western Maryland Railway; West Virginia Route 46 and utilities; and the construction of housing and shop facilities and access roads.

A formal dedication ceremony sponsored by a committee of citizens, dignataries, and businessmen from the general project area was held at the dam site on 20 September 1981. Senator Jennings Randolph, the keynote speaker, together with the other speakers expressed the hope for the fulfillment of the dreams envisioned in the planning and construction of the project. The project was operationally complete in July and water was immediately impounded as a contingency for possible drought conditions in the Potomac this Fall. Fortunately, the drought did not occur and we are able to continue filling the reservoir on the initial plan. Current elevation is 1350 with a 60 day hold in effect.

With that overview of the Bloomington Project, I would now like to return to the Bloomington Lake Reformulation Study itself. In order to satisfy the study objectives, the study will include several major activities.

## OPERATIONAL ANALYSIS

In Phase I of the study, we are investigating the water supply potential of the Bloomington Lake Project as authorized. The Phase I analysis has also included collection and evaluation of water quality

data, environmental and recreational facilities information, and flood damage field spot checking, and other related activities such as fish and wildlife investigations and flow loss and travel time studies.

In Phase II of this study, we will investigate the feasibility of storage reallocation, i.e., transferring the water quality and/or flood control storage to water supply storage.

The Corps fully recognizes the importance of public involvement in the achievement of project objectives. Our public involvement program is geared to three basic measures to promote communications with the project area residents: (1) general information; (2) interaction - dialogue; and (3) review - reaction. Printed material such as the notice of study initiation, Water Forum Notes, and public meeting announcements are used to keep the general public informed about the progress of the study. Public workshops and public meetings will be used to encourage interaction dialogue between Corps representatives and the interested or affected public. Review reaction will be achieved through formal conferences with potential water supply storage purchasers. Study reports will also be made available throughout the study.

A Citizens Task Force for the North Branch Basin was organized this spring and the initial meeting of the group was held in April. Water Forum Notes will be prepared which will inform the general public about the study progress. Our November 1980 Progress Report has also been mailed to Federal, State, and local agencies and to many individuals for their information and review.

## COORDINATION

The study is being coordinated with Federal, State, and local agencies. Copies of study documents, most notably the November 1980 Progress Report, have been mailed to members of the Federal-Interstate-State-Regional (FISRAC) Committee; ICPRB, NAS/NAE, members of the Citizens Task Force to review the Washington Water Supply Study, Potomac users, utilities, and others interested in the study.

Let's look at where we are in the Reformulation Study in our overall desire to meet the water needs of users along the Potomac.

As I mentioned before, the Bloomington Lake Reformulation Study was initiated in 1978. A preliminary evaluation using available data was prepared in April 1979. Results of the preliminary evaluations indicated that a more detailed analysis was warranted. Since then, work on the study elements shown here has progressed and I would like to provide a brief overview on the work completed to date.

The PRISM model was initially developed by the Johns Hopkins University as part of their efforts to investigate management of water resources in the MWA. The PRISM model is a basin specific model which calculates the inflows, storages, and releases from the Bloomington and Savage reservoirs on a weekly basis and evaluates their impact on water availability in the Washington Area. It incorporates the Low Flow Allocation Agreement and simulates the downstream reservoir operation to calculate water deficits for the three Potomac River users; Washington Aqueduct (WAO), Fairfax County Water Authority (FCWA), and Washington Suburban Sanitary Commission (WSSC). We have modified and expanded the model to include separate accounts for water supply and water quality storages and use of modified rule curves for Bloomington and Savage River projects. These modified rule curves allow drawdown of Bloomington and Savage projects during winter for increased flood control in the spring.

The PRISM model relies on several data files and basic assumptions. These data files contain weekly flow data for all of the MWA water supply sources, weekly evaporation rates for the reservoirs, and the rule curves.

I might add that the average annual demands for the three Potomac users, Aqueduct, WSSC, and FWCA are calculated within the PRISM and are based on a given set of equations for each service area. The interactive portion of the program allows selection of both the year of investigation and conservation level.

The important PRISM assumptions are:

(1) Bloomington releases reach MWA intakes undiminished in seven days.

(2) Savage storage and Bloomington water quality storage would be used to satisfy a flow target at Luke, Maryland. Bloomington water supply storage would be tapped only when releases for the Luke target would not provide sufficient flow to meet MWA demands.

(3) WSSC and FCWA can furnish water to all of their respective service areas from their Potomac treatment plants.

(4) Stream flows at Little Falls can be predicted for the following week with reasonable accuracy.

The purpose of using PRISM model for the Bloomington Reformulation Study is to optimize the operating rule or to identify operating schemes which make efficient use of the available water supply. This would require thousands of computer runs at an unacceptable cost. Therefore, certain modeling objectives were established and a logical series of test runs were formulated to meet these objectives. These modeling objectives include:

(1) To determine how effective the operational strategy proposed in the project authorization document would be in satisfying MWA water supply demands.

(2) To assess the effect of different flow targets at Luke or upstream targets on reservoir storages and MWA deficits. The upstream target is the desired stream flow at Luke necessary to maintain certain water quality standards in the stream as affected by the industrial waste discharges and acid mine drainage.

(3) To determine the best balances between releases from the upstream reservoirs (Bloomington and Savage) and withdrawals from the downstream reservoirs or downstream target. The downstream target reflects the degree of reliance on downstream reservoirs to meet the MWA water supply needs.

(4) To investigate the effects of different water supply and water quality storage volumes in the Bloomington Lake or low flow augmentation storage reallocation.

(5) To determine the effects of different water supply and flood control storage volumes in the Bloomington Lake or flood control storage reallocation.

(6) To assess the effect of different environmental flow-by values on the MWA water supply deficits.

Based on these modeling objectives and using the assumptions as described for the purpose of the preliminary analyses, 46 PRISM test runs were made. Of the 43 model variables, 12 were used for these test runs and the other 31 were kept constant. The results of these test runs indicate that the variables which would significantly impact the results would include the following:

(1) Flow at Luke or the upstream target - The project authorization document assumes that a flow of 197 million gallons per day (mgd) can be maintained at Luke during the low flow period. If we do that and operate the Bloomington Lake project for a constant flow of 197 mgd, it would result in large deficits for the Washington Area.

(2) Reliance on downstream reservoirs or the downstream target - Frequent use of the downstream reservoirs or greater reliance on the downstream reservoirs could retain the Bloomington storage for the Washington Area.

(3) Flow-by - Your next presentation by Mr. Wheeler of the State of Maryland, will address this detailed study of flow-by as required under the terms of the Low Flow Allocation Agreement. The level of flow-by is most certainly a critical element in managing the water resources of the region.

In addition to these three major variables, there are several other variables which may not have significant impact when used individually but their accumulative effect would be quite measurable. These variables include treatment and withdrawal capacities of the Potomac River users, upstream consumptive withdrawal, and year of freeze of the Low Flow Allocation Agreement.

While the results of these early PRISM runs were very beneficial in helping to identify the critical parameters, the results were considered preliminary pending completion of other studies to include water quality investigations, flow loss and travel time studies, and the State of Maryland's flow-by study.

We have completed our analysis of flood flows to include the development of rainfall-runoff characteristics, storage frequence and peak flow frequency relationships, and probable maximum floods. Flood damage data in downstream communities has been field checked and revised to reflect the changes which have taken place since the original studies were conducted in 1960. Also, the impacts of higher pool elevations on the upstream community of Kitzmiller were investigated and found to have no effect.

Our water quality investigation has included collecting all existing water quality data from Federal and State sources and developing a water quality model. The model was developed to determine an upstream flow target at Luke, Maryland, which would meet present water quality needs based on both existing and expected future conditions in both Bloomington Lake and the basin in general.

Environmental and recreation related-studies are being coordinated jointly by the Corps and the U.S. Fish and Wildlife Service. The principal thrust of the investigations is to determine the impacts of various operating and reallocation alternatives on both fish and wildlife resources and recreational use.

A detailed flow loss and travel time study has been conducted by the U.S. Geological Survey to determine the response time and losses at Washington, D.C. of varying release rates from the Bloomington and Savage projects. Preliminary results of this study indicate that flow losses between the projects and Washington, D.C. are negligible and that during low flow periods, nearly all of a daily unit release of the project could be expected to reach Washington, D.C. within one week.

Last, as I had mentioned earlier, a Progress Report presenting the results of our early study efforts to include the initial PRISM model runs was published and distributed in November, 1980.

Generally speaking, the collection of the raw data and the development of the models required to analyze the feasibility of reallocation have been completed. Given the results of the USGS

travel time and loss studies, the water quality findings, the projected water demands, and the results of Maryland's flow-by study, a second series of PRISM computer runs will be made. The results of these runs will, among other things, provided some insight into the sensitivity of the existing system to flow-by values from 100 to 500 mgd.

Using the output from the PRISM model project, alternatives, i.e., operational changes and reallocation operations, are being formulated and the environmental and economic impacts of these alternatives will be evaluated. The impact assessments will generally focus on:

(1) the ability of the project to meet additional downstream water supply needs;

(2) defining any changes in downstream flood protection; and

(3) defining the environmental related impacts of any proposed change in the existing project.

Given the results of the formulation and assessment process, a recommended plan will be selected and the entire study process and findings will be documented in a draft report.

The draft study report will be completed in September 1982 and will contain results of all the efforts which went into accomplishing the study objectives. The final report will be completed in September 1983 along with the report for the entire Washington Water Supply Study.

It should be noted that changes to the existing project storage allocation will not be recommended unless they are found to be in the best overall public interest. Changes in local cooperation requirements caused by the storage reallocation, substantial changes in the project scope, or the addition or deletion of project purposes, if required, will be recommended to our higher authorities. If they are significant, Congressional approval could be required before project modifications could be accomplished.

# THE POTOMAC RIVER LOW FLOW ALLOCATION AGREEMENT AND THE ENVIRONMENTAL FLOW-BY STUDY

by

Charles A. Wheeler

## INTRODUCTION

During the latter half of the 1970's, water resources management in the Washington Metropolitan Area turned from the traditional approach of planning to meet unrestricted water supply demands 100 percent of the time to an effort to plan for management of available resources during periods of shortage. Under this strategy and recognizing that from time to time flows in the Potomac River may be less than the demand for water for the Metropolitan Region, the need for a mechanism to equitably distribute a limited resource was evident. This mechanism was, and is the Potomac River Low Flow Allocation Agreement (LFAA). The LFAA is unique in that it brings together the Federal Government as both a regulator and water purveyor, two States and the District of Columbia, and two major water supply utilities in a common understanding and consensus for water management. It is also noteworthy that the signatories to the LFAA recognized the importance of instream needs. In fact, the LFAA sets the instream need as first priority before remaining water is allocated to other uses.

To determine the amount of water necessary for instream needs, the LFAA charged the State of Maryland with conducting a joint study and preparing recommendations to the Corps of Engineers for the minimum environmental flow-by. The recommendations included a minimum 100 mgd flow-by over Little Falls Dam, a shift in points of withdrawal during low flow for the Washington Aqueduct and further investigation of the potential for establishing a schedule of flows in the River to optimize fisheries management.

## THE AGREEMENT

On the surface, the Potomac River Low Flow Allocation Agreement provides a mechanism for responding to drought or other water shortage emergencies. While it has been demonstrated to be an effective tool

for this purpose, it represents an even more significant position with respect to water resources management in the Potomac Basin. Heretofore, planning for water supply and resource management has been based on a fundamental pattern of constructing dams and reservoirs and developing additional sources of water adequate to meet unrestricted demand. The LFAA was the first tangible evidence of the shift in management strategy. The objective now is to plan for water shortages. Important too is that this concept has been adopted by nearly all parties with an interest in the Potomac Basin.

The State of Maryland, as proprietor of the Potomac River (the Maryland State line runs along the Virginia/West Virginia shore with the exception of the District of Columbia and Bloomington Lake) and as charged by statute with managing the State's resources, implemented a water appropriation permit system in 1933. All appropriators of water from the Potomac River including Virginia which are not otherwise exempt are required to obtain a permit from the Department of Natural Resources. This permit system is the regulatory framework within which Maryland manages the State's water resources and is a significant part of Maryland's role in the Potomac Basin.

Virginia's interest as riparian user is to have an adequate water supply available from the Potomac. It should be pointed out that under Maryland Water Law there is no preferential treatment to in-state users; Virginia water users are treated as if they were Maryland users. The District of Columbia likewise has an interest through their need for a water supply and in particular their situation as the last intake on the Potomac and thus, very much susceptible to what happens with upstream water uses. The Corps of Engineers, which normally has regulatory responsibilities, has a dual role here in that they are also the purveyor of water for the Federal Government and the District of Columbia.

The interested parties are the State of Maryland and the Commonwealth of Virginia, the Federal Government through the Corps of Engineers as Federal representatives and a water utility, the District of Columbia and two major metropolitan water supply utilities -- the Washington Suburban Sanitary Commission which supplies water to Montgomery and Prince George's Counties in Maryland and the Fairfax County Water Authority which supplies metropolitan Virginia. Uniquely enough, each of these parties came to a mutual understanding of what some of the problems in the Potomac were and what mechanisms could be used to solve those problems. Negotiations culminated in the signing of the LFAA in January of 1978.

The LFAA is composed of several Articles. It provides important legal mechanisms for preservation of each party's interest and an enforcement mechanism to be exercised by appointment of an independent moderator to resolve any conflicts that may arise. As a management tool, the document distributes equitably available water during time of drought to all users of the River. This is accomplished by providing for a control center, manned by the Corps of Engineers, which receives



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input from each of the users on how much water they are using and input from gaging stations on how much water is available. Decisions can be made on a daily basis according to a prescribed formula on how much water can be allocated to the users.

The LFAA is structured into three stages of water supply availability. The first of these, the "Alert Stage" is instituted when the total daily withdrawal from the defined portion of the River is equal to, or greater than, fifty percent (50%) of the total daily flow. The "Restriction Stage" is instituted when the total daily withdrawal is equal to, or greater than, eighty percent (80%) of the total daily flow and the "Emergency Stage" is instituted when the estimated daily withdrawal is expected to exceed the daily flow anticipated. Whenever the restriction or emergency stage is in effect, the Corps of Engineers will advise each user of their allocated fair share. The document also provides flexibility so that as changes occur in the River or in the uses, the signatories can get together and revise any section to meet current requirements.

Significant, for an agreement among government agencies and water supply utilities, is that the LFAA not only addresses the needs of the various water supply utilities, but also recognizes the need for water to be made available for instream uses. The instream need, or what has been termed the environmental flow-by, is the amount of flow necessary to maintain fish and aquatic life in the portion of the River most affected by low flow. This portion as defined by the LFAA is from Seneca Pool down to Little Falls dam wherein all of the metropolitan water supply intakes are located. Those intakes, of course, have the most impact on the River at the time of low flow.

## THE STUDY

Article 2C of the LFAA spells out the necessity for addressing instream needs during low flow. Specifically, "In calculating the amount of water available for allocation in consultation with the parties and based upon current conditions and information, any amount of flow needed in the downstream portion of the River for maintaining environmental conditions shall be included and that need shall be balanced against the essential human, industrial, and domestic requirements for water supply." Further, the State of Maryland was charged with responsibility for developing recommendations as to what the environmental flow-by should be.

The LFAA was signed in January of 1978 and in the spring of that same year the State of Maryland proceeded to put together a task force to develop a study design that would address all of the various impacts of low flow on the River including fish and wildlife, recreation, aesthetics, and water quality, and generate a schedule of flows and attendant impacts which could be used to develop recommendations.

The Task Force was made up of the signatories to the LFAA, the U.S. Geological Survey, EPA, the Interstate Commission on the Potomac River Basin, the Potomac River Fisheries Commission, the U.S. Fish and Wildlife Service, and other State agencies. In developing the study, there was much concern about the impact of low flows on the estuary. There were those who believed that the flow-by would be of such short duration and the quantities of water so small that any potential impact or affect on the fresh water estuary would be negligible. There were others who were extremely concerned about water quality changes in the estuary as a result of reduced fresh water inflows. Accordingly, the estuary was included in the study despite the fact that it was outside the area of the study charge.

The remainder of the study was directed towards impacts on the fluvial portion of the River between Seneca Pool and Little Falls dam. The potential impacts included those on the fishery, macro-invertebrates, wildlife, recreation, the Chesapeake and Ohio Canal, water quality (bacteria, dissolved oxygen, sedimentation), and others. As work progressed, it was soon realized that some of the early predictions about minimal impacts on the estuary were probably true. From ongoing studies by the U.S. Geological Survey, the Corps of Engineers, and the EPA directed toward different aspects of the estuary and the flow-by numbers that were being considered as being physically possible with mandatory water use restrictions, it was evident that there would be little if any impact on the estuary. With this matter put to rest, the emphasis of the study shifted and efforts were concentrated on the fluvial portion of the River.

In the early stages of design, the task force determined that it would be desirable to attempt to make use of the incremental methodology computer models developed by the Instream Flow Group (IFG) of the U.S. Fish and Wildlife Service. The "IFG" methodology utilizes indicators of fish habitat availability, compared at different flows, to determine fish electivity curves for representative species and life stages at projected flows. Since these computer models had been developed utilizing smaller western streams it was necessary to train study participants in the application of the models and adaptation to conditions on the Potomac.

The field work required setting up a series of transect stations, twelve in all, in various hydraulically different stretches of the River that would be representative of each flow regime. Each station was analyzed for depth, substrate type, and velocity and these data entered into the computer. These measurements were taken during the summer of 1978 at a moderately low flow (1,292 mgd), again in the summer of 1980 at a very low flow (840 mgd), and a third time in the fall of 1980 at a somewhat higher flow (2,261 mgd). No data could be collected during 1979 due to record high flows. The collected data were run through the computer model, corrected and massaged to produce results that could be utilized in conjunction with the other non-modelled data.

A matrix of low flow and attendant impacts was prepared utilizing the modelled and non-modelled data. The matrix described impacts within a flow range of 100 to 1,200 mgd for each of the parameters studied. Some impacts were evidenced at flows of 700 mgd such as canoeing and kayaking, whereas others were not significant at even 100 mgd. It became evident that a single recommendation for a minimum flow-by would not be adequate to address the needs of the River at low flow. A flow-by in one section of the River might be adequate but could adversely impact another. There was also a tremendous potential for significantly improving the fishery habitat by controlled adjustments of River flow.

## THE RECOMMENDATIONS

The first and perhaps most critical recommendation to come out of the study was the minimum flow-by to be permitted over Little Falls dam. This is important in that it sets the lowest quantity of water that will be allowed to flow from the dam to the estuary and still prevent irreparable damage to the resource. Of much greater significance, however, is that it also sets the flow at which the LFAA is triggered and subsequent water use restrictions implemented. The minimum daily environmental flow-by was established at 100 mgd. Not only was it reasonable in terms of the magnitude of impacts it was also a number that could easily be applied and enforced. It should also be noted that historically the River had declined to 60 mgd during the 1966-67 drought and while there were some severe impacts, the River managed to recover from a flow that low. Thus the recommendation would be setting a higher limit than what had occurred naturally in the past.

As was mentioned, the first recommendation would have satisfied the study charge. However, during the course of data analysis, it became evident that the stretch of River between Great Falls and Little Falls was particularly prolific in terms of fishery habitat and needed more consideration than would be provided by the 100 mgd flow-by.

Accordingly, a second recommendation was developed. This recommendation called for a shift in withdrawal locations by the Washington Aqueduct. The Aqueduct is operated by the Corps of Engineers and obtains water under normal conditions from an intake located at Great Falls. Water then flows by gravity to the water treatment plant at Dalecarlia. The Aqueduct also has an intake located at Little Falls dam. Utilization of this intake however requires pumping, with its attendant costs, to the water treatment plant. This is estimated to be about $8,000 per day. There is approximately an eight mile stretch of River between the two intakes which, as was indicated, has significant fisheries value.

The second recommendation, therefore, was to request that the Aqueduct begin shifting withdrawals at a river flow of 500 mgd from the Great Falls intake to the Little Falls intake. This would allow the quantity of water that they normally distribute to their users (about 200 mgd) to flow past their upstream intake and down to the lower intake thereby providing that additional quantity of water for maintenance of fishery habitat in that section of the River.

The above recommendations could adequately address the needs of the river during low flow conditions. Although again beyond the charge of our agency, there was a necessity for looking at the potential for optimizing fisheries habitat in the Potomac. Since by definition the flow-by study was done without consideration of the Bloomington Lake and, as is well known, that reservoir is now on line and water is being impounded, it is clear that additional opportunities exist for resource management.

The third recommendation was, upon completion of the Bloomington Lake, to establish a monthly flow schedule based on existing information regarding water management opportunities that will optimize instream values and at the same time meet the water supply needs of the downstream users. The State of Maryland is implementing that recommendation by soliciting the views of the LFAA signatories and other study participants concerning the establishment of a task force to proceed with data evaluation and formulation of recommendations with regard to optimizing the fishery habitat in this portion of the River. It is important to note that future management flows do not supercede nor negate the 100 mgd minimum environmental flow-by. The flow-by is the bottom line flow for protection of the River irrespective of the management flows developed in the future.

## THE ACCEPTANCE

Each of the recommendations, together with the data and analysis used; were presented to the signatories of the LFAA in July in this year [1981]. It was gratifying to the State of Maryland that the first two recommendations, the 100 mgd flow-by and the required shifting of withdrawals, were unanimously adopted and formally recommended by that body to the Corps of Engineers. The Corps in turn favorably received the recommendations and agreed to abide by the terms thereof for this year, particularly since the status of Bloomington water availability was still unknown. The third recommendation for future management did not require action by the signatories, however, Maryland was given the "go ahead" to pursue the advisability of conducting this additional study.

The flow-by study was presented in July as a draft. Subsequently, many comments and suggestions were received and some editorial and data modifications were made to the text. The comments did not, however, change the basic recommendations. [The final report was published in January of 1982.]

Maryland is confident that this study will establish a framework for future management options that may be available in the Potomac with the advent of Bloomington and possibly a local reservoir yet to be constructed.

# STATUS OF THE POTOMAC ESTUARY EXPERIMENTAL WATER TREATMENT PLANT PROJECT

by

Harry C. Ways

The Potomac Estuary Experimental Water Treatment Plant Project was authorized by Congress in the 1974 Water Resources Development Act, as a part of the overall Metropolitan Washington Area Water Supply Study. The purpose of the project is to study the feasibility of utilizing the Potomac River Estuary as a major source water supply, by evaluating treatment effectiveness in meeting drinking water standards, efficiency, reliability and costs.

The Estuary is but one of several alternatives being considered to meet the long range water supply needs of the area. Others include demand reduction, more efficient use of existing facilities and increasing the raw water supply. Construction of the treatment plant was completed at a cost of $9.5 million. The operating, testing and evaluation will cost over $11 million. The plant, located at the DC Blue Plains Waste Water Treatment Plant, has a maximum capacity of 1 million gallons per day.

The facility was designed by Malcolm Pirnie, Inc., and built by the Baltimore District of the Corps of Engineers. Technical and administrative supervision of the project is the responsibility of the Washington Aqueduct Division. Plant operation and the water quality testing program is being performed by the James M. Montgomery Consulting Engineers, under contract to the Corps.

Following a 6-month startup period, the first year testing program began in March 1981. This phase will include a full year of operation of standard process combination at a 0.5 mgd rate; comparison of experimental plant effluent with finished waters from plants now serving the metropolitan area; process evaluation, bench scale optimization studies and preliminary cost estimates.

During the second year of operation, beginning in March of 1982, the treatment process will be modified to include evaluation of alternative treatment trains, coagulant recovery, demineralization, and the use of alternative disinfectants. Preparation of the final report will take 6 months. When completed in September 1983, it will be submitted to Congress and also to the National Academy of Science and the National Academy of Engineering for a one-year review.

Throughout the program optimization of organics removal will be stressed. Both plant scale and bench scale tests will be utilized, including variation in types of granular activated carbon, carbon column flow rates, air stripping, use of ozone, and alternative coagulants and disinfectants. Chlorine dioxide, ozone and ultra-violet light are available. There will also be comparison studies of total dissolved solids removal by reverse osmosis, electrodialysis and ion exchange, utilizing a 10,000 gallons per day (gpd) side stream.

Coagulant recovery facilities, including sludge thickner, carbonation-acidulation tanks, classifying centrifuge and a multiple hearth furnace, will be operated during the second year. These studies will determine the cost effectiveness of recovery and reuse of alum and lime-magnesium carbonate.

The plant influent is provided from two sources of raw water; an intake pipe located 1100 feet into the estuary, and nitrified secondary effluent from the Blue Plains Waste Water Treatment Plant. The water now being processed is a 50/50 mix from these two sources. This mix was selected to best simulate projected estuary quality in the year 2020 under drought conditions, based on data from the EPA Dynamic Estuary Model.

The treatment train and operating criteria selected for the first year of operation are shown in Table 1. The only significant departure from conventional treatment processes being utilized by the water utilities now serving the area is the inclusion of granular activated carbon adsorption. Both up-flow and down-flow carbon tanks are available, and they can be operated in series or parallel. Two down-flow columns are currently being utilized, in series, providing a contact time of 15 minutes. Regeneration time is from 8 to 12 weeks. The carbon is sent to Texas for regeneration. It was uneconomical to provide carbon regeneration facilities on site for a program of such short duration.

A significant objective of the project is the development of data to compare the estuary plant effluent with the finished waters now utilized by residents of the area. An extensive testing program on finished water from the three largest local water treatment plants is included in the project. The extensive routine water quality testing program at the plant and the local water treatment plants is shown on Table 2. Results are being obtained for 29 metals and 120 synthetic organic chemicals.

The scope of the testing being done far exceeds the requirements established by EPA under the Safe Drinking Water Act. The toxicological and virus testing program, in particular, represents a significant departure from normal water testing procedures. The virus tests are being run through three cell lines. The Ames Test provides mutagenicity factor, and the Mammalian cell tests are to detect potential carcino-genicity. These tests are quite expensive. Virus tests cost $525

**TABLE 1**

**PROCESS SEQUENCE AND PROPOSED OPERATING CONDITIONS**
**FIRST YEAR PLANT OPERATIONS - EEWTP**

| | Unit/Process | Operating Conditions |
|---|---|---|
| 1. | Influent mix-estuary/nitrified effluent | Equal mix<br>Q = 0.5 mgd (350 gpm) |
| 2. | Microscreens | 35 um polyester fiber screen. Combined flow through one unit 7.3 gpm/$ft^2$ |
| 3. | Aeration | Surface aerator<br>2 hp/1000 $ft^3$<br>Detention time (D.T.) = 20 mins. |
| 4. | Rapid mix | 2 tanks in series<br>D.T. = 1 min/tank<br>G = 400 $sec^{-1}$ |
| 5. | Coagulants | Primary: alum<br>Dose = 40-70 mg/L as alum<br>Coagulant aid: anionic polymer (Hercofloc 1018)<br>Dose = 0.1 - 0.5 mg/L as required |
| 6. | Flocculation | Two tanks in series<br>D.T. = 20 min/tank<br>Vertical turbine<br>G (tank 1) - 80-100 $sec^{-1}$ (50-60 rpm)<br>G (tank 2) = 40-60 $sec^{-1}$ (35-45 rpm) |
| 7. | Sedimentation Basin | Horizontal: submerged weirs<br>Detention Time = 4.5 hours<br>Q/A = 470 gpd/$ft^2$ (0.84 m/h) |
| 8. | Intermediate Disinfection | Disinfectant: $Cl_2$<br>Target Residual: 1 mg/L, total $Cl_2$<br>Dose = 2-10 mg/L<br>Contact time = 10 sec ahead of filter |

TABLE 1

PROCESS SEQUENCE AND PROPOSED OPERATING CONDITIONS
FIRST YEAR PLANT OPERATIONS - EEWTP
(Continued)

| Unit/Process | Operating Conditions |
|---|---|
| 9. Filters | Dual Media: 20" anthracite/10" sand<br>Flow rate = 2.9 gpm/$ft^2$ (7.3 m/h) with two filters in operation.<br><br>Rate control: rate of flow control effluent control valve<br><br>Filter aid - none at present<br><br>Backwash: surface wash, backwash at maximum flow of 16 gpm/$ft^2$ (40 m/h) |
| 10. GAC Columns | Carbon: ICI 816 Hydrodarco (lignite based carbon)<br><br>Empty Bed Contact Time (EBCT)/Column = 7.5 min (Totle EBCT = 15 min.)<br><br>Bed Depth = 9 ft. (2.74 m)<br><br>Q/A = 9 gpm/$ft^2$ (22.5 m/h)<br><br>Operation: 2 downflow pressure columns in series<br><br>Proposed regeneration criteria:<br>a) TOC removal 50% or<br>b) TOX 100 ug/L<br><br>Method of regeneration: Off-site by ICI |
| 11. Post Disinfection | Disinfectant: $Cl_2$<br><br>Dose: 2-6 mg/L<br><br>Contact Time: 60 min.<br><br>Chlorine residual target: between 1 and 2 mg/L free $Cl_2$ |

per Sample, Ames tests $366 and Mammalian Cell $3,700. The Laboratory Testing Program accounts for nearly 35 percent of the total operating cost.

Early results from the testing program are summarized in Tables 3 through 8. In general, the experimental estuary plant effluent compares favorably with the water produced by the water treatment plants now serving the Washington Area. The nitrite concentrations are considerably higher, and approach the permissible limits in some cases. This is due to the direct utilization (50 percent) of nitrified Blue Plains Effluent. The high manganese results, which arise from the same source, have subsequently been reduced by the addition of $MMn\ O_4$. The estuary plant is producing water with lower values for Total Organic Carbon, Total Organic Halogen and Total Trihalomethanes than that produced by local water treatment plants. This is due to the granular activated carbon facilities available only at the estuary plant. All plants surpass the 100 ug/l standard for Trihalomethanes.

Work accomplished to date includes plant design and construction, testing program formulation, plant break-in and six months of operation and testing. Plant operation and testing will continue for another 18 months, with modifications in treatment trains, bench scale studies and lab testing programs as appropriate. Six months later, in September 1983, the final report will be submitted to Congress and to the National Academies of Science and Engineering for review and comment. At this point I would summarize the status of the project by saying "The hardest parts are behind us, the most interesting parts lie ahead."

TABLE 2

POTOMAC PROJECT
ROUTINE WATER QUALITY TESTING PROGRAM

| | SITES | | | | | | |
|---|---|---|---|---|---|---|---|
| | Blue Plains | Estuary | Blend | Filter Effluent | GAC Effluent | Finished Water | Local WTPs (3) |
| Parameter | 1 | 2 | 3 | 6 | 13 | 16 | |
| Total/Fecal Coliform | DG | DG | -- | -- | DG | DG | |
| Viruses/ Parasites | MG | MG | -- | MG | MG | MG | MG |
| Ames | -- | -- | -- | -- | -- | WG | WG |
| Mammalian | -- | -- | -- | -- | -- | MG | MG |
| TOC | DC | | DC | C | C | DC | DC |
| TOX | DC | | DC | | DC | DC | DC |
| TTHMs | | | S | | S | S | S |
| SOCs | | | T | | T | T | T |
| Metals (29) | | | DC | DC | | DC | DC |
| Minerals | DC | DC | DC | | DC | DC | DC |
| Asbestos | WC | WC | WC | WC | | WC | WC |

S = DC Twice/week
T = 3 day composite/3 weeks
DC = Daily composite
DG = Daily grab
MG = Monthly grab
WG = Weekly grab
C = Continuous

TABLE 3

POTOMAC PROJECT
COMPARISON OF EFFLUENTS
MICROBIOLOGICAL CONTAMINANTS

| Parameter (MQL) | | EEWTP | WTP 1 | WTP 2 | WTP 3 |
|---|---|---|---|---|---|
| Total Coliform | N | 43 | 36 | — | — |
| (0.02/100 ml) | Median | 0.08 | ND | | |
| | 90% | 0.23 | ND | | |
| Viruses | N | 2 | 2 | 2 | 2 |
| (1 PFU/1250 L) | Median | ND | ND | ND | ND |

TABLE 4

POTOMAC PROJECT
COMPARISON OF EFFLUENTS METALS

| Parameter (MQL) | | EEWTP | WTP 1 | WTP 2 | WTP 3 |
|---|---|---|---|---|---|
| Arsenic (.0002) | N | 42 | 21 | 36 | 32 |
| | Median | ND | .0003 | .0002 | .0002 |
| | 90% | 0.005 | .0006 | .0005 | .0004 |
| Cadmium (.0008) | N | 42 | 21 | 36 | 32 |
| | Median | ND | ND | ND | ND |
| | 90% | .001 | .008 | .0012 | ND |
| Chromium (T) (0.003) | N | 42 | 21 | 36 | 32 |
| | Median | ND | ND | ND | ND |
| | 90% | ND | ND | ND | ND |
| Lead (.0003) | N | 42 | 21 | 36 | 32 |
| | Median | ND | ND | ND | ND |
| | 90% | .001 | .001 | .002 | .001 |

TABLE 5

POTOMAC PROJECT
COMPARISON OF EFFLUENT INORGANIC PARAMETERS

| Parameter (Units) | | EEWTP | WTP 1 | WTP 2 | WTP 3 |
|---|---|---|---|---|---|
| TDS (mg/L) | N | 69 | 70 | — | — |
| | Median | 239 | 142 | | |
| | 90% | 300 | 171 | | |
| Nitrate + Nitrite (mg-N/L) | N | 41 | 19 | — | — |
| | Median | 8.3 | 1.5 | | |
| | 90% | 9.8 | 2.2 | | |
| Sodium (mg/L) | N | 42 | 21 | 36 | 32 |
| | Median | 25.5 | 7.3 | 11.9 | 7.6 |
| | 90% | 28.8 | 10.2 | 12.6 | 10.1 |
| Manganese (mg/L) | N | 42 | 21 | 36 | 32 |
| | Median | .06 | .003 | .004 | .003 |
| | 90% | 0.17 | .006 | .009 | .008 |
| Asbestos (mf/L) | N | 10 | 10 | 11 | 10 |
| | Median | ND | ND | ND | ND |
| | 90% | ND | 0.13 | 0.13 | 0.26 |

TABLE 6

POTOMAC PROJECT
COMPARISON OF EFFLUENT ORGANIC PARAMETERS

| Parameter (Units) | | EEWTP | WTP 1 | WTP 2 | WTP 3 |
|---|---|---|---|---|---|
| TOC | N | 61 | 38 | 53 | 45 |
| (mg/L) | Median | 1.2 | 1.8 | 3.6 | 2.0 |
| | 90% | 1.9 | 2.4 | 5.0 | 3.3 |
| TOX | N | 59 | 38 | 53 | 45 |
| (ug/L) | Median | 145 | 280 | 310 | 350 |
| | 90% | 230 | 415 | 355 | 460 |
| TTHM | N | 24 | 24 | 21 | 20 |
| (ug/L) | Median | 11 | 60 | 46 | 52 |
| | 90% | 30 | 88 | 56 | 76 |

TABLE 7

POTOMAC PROJECT
SUMMARY - FINISHED WATER QUALITY
ANALYSES FOR SYNTHETIC ORGANIC CHEMICALS

| Fraction (MQL, ug/L) | Compounds Searched | Compounds Found (greater than MDL) | Compounds Quantified |
|---|---|---|---|
| Purgeable Volatile Organics (0.1) | 53 | 44 | 9 |
| BNAs (0.1-10) | 56 | 7 | 3 |
| Pest/Herb/PCB (0.1-1.0) | 27 | 0 | 0 |



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TABLE 8

POTOMAC PROJECT
COMPARISON OF EFFLUENT SYNTHETIC CHEMICALS

| Compound (MQL ug/L) | | EEWTP | WTP 1 | WTP 2 | WTP 3 |
|---|---|---|---|---|---|
| $CCl_4$ | Median(1) | NQ | NQ | NQ | NQ |
| (0.1) | 90% | 0.1 | NQ | 0.1 | NQ |
| PCE | Median | NQ | NQ | NQ | NQ |
| (0.1) | 90% | 0.1 | NQ | NQ | NQ |
| Dibutyl | Median | ND | ND | ND | ND |
| Phthalate | 90% | ND | ND | ND | ND |
| (0.5) | | | | | |

(1) Based on eight samples, 3-day composites

# ASSURING WATER SUPPLY FOR THE WASHINGTON METROPOLITAN AREA: TWENTY-FIVE YEARS OF PROGRESS

by

DANIEL P. SHEER

I would like to dedicate this paper to the late Melvin E. Scheidt, a long time member of this American Water Resources Association Chapter. It presents a historical prespective of the technical aspects of managing the water resources in the Potomac Basin. First is a technician's history, more or less a listing of major events. Second is a description of the existing system, its operating objectives, and the problems of operating to meet those objectives. Then the paper covers the techniques and the tools which are available to solve these problems. Finally, the issues of wider applicability of these techniques are presented.

From 1950 to 1955, the Congress passed several resolutions requesting the U.S. Army Corps of Engineers (COE) to review a document prepared during World War II, concerning hydropower and flood control development in the Potomac Basin. It is interesting that the COE, at that time, found that there were no feasible hydropower sites on the Potomac. The only flood control projected by the COE was for the protection of the Nation's Capital. In 1956, following a drought, Congress passed a resolution for a complete study of the Potomac Basin. The resulting study has been the basis for most of the work since that time.

In 1956 the plan of work for that study was prepared by a consulting firm called Day and Zimmerman. This plan of work is particularly interesting. It contains a simple mass analysis diagram of the Potomac River at Washington (Figure 1). The diagram was used to estimate storage needed to augment the flows of the river at Little Falls and to provide water for Washington. It is simple and straight forward. The report concluded that a substantial but not exorbitant amount of storage would be required.

In the intervening years, this insight was lost in the attempt to formulate plans which were all things to all people. It was 21 years later before the concept was rediscovered.



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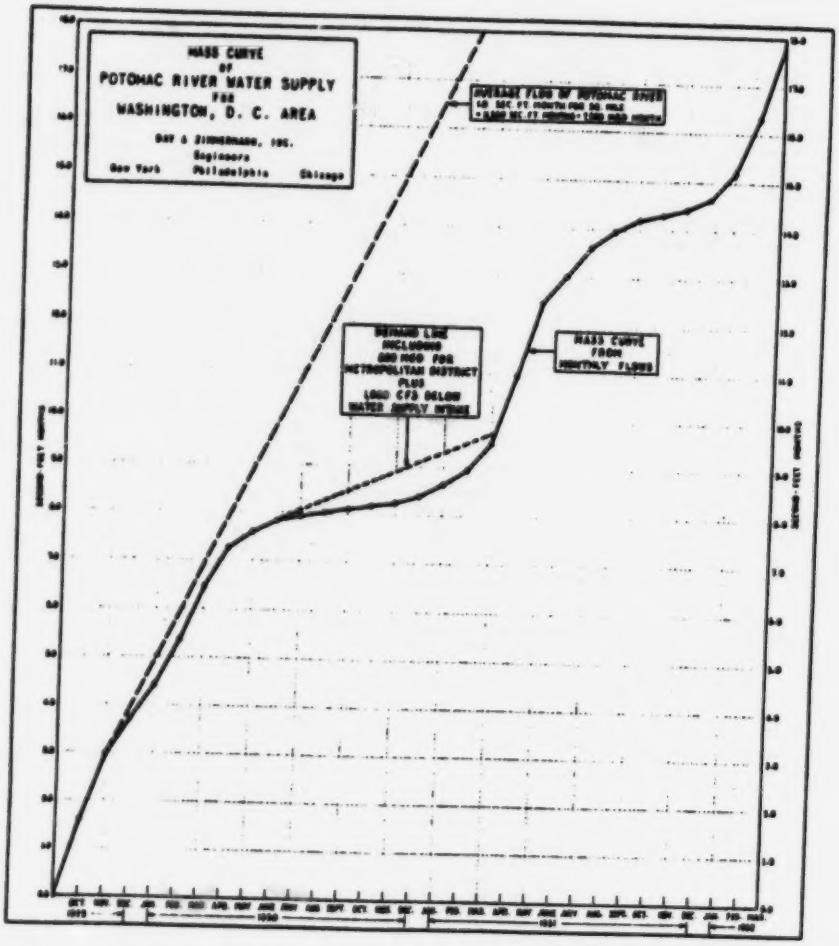
**FIGURE 1**



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In 1962 the first portion of the Potomac study, the North Branch Report, was released. This, as well as the 1963 Report, was produced in large part by Harry Schwartz, one of the unsung heros of the Potomac. The work he did was extraordinarily comprehensive. The study recommended that Bloomington Lake be used to fulfill the projected demands on the North Branch (Figure 2). Note that in 1963, 93 cubic feet per second (cfs) was the dependable supply. Figure 2 notwithstanding, demands have not increased. It is very difficult to predict water demands into the future, a lesson we should all know by now.

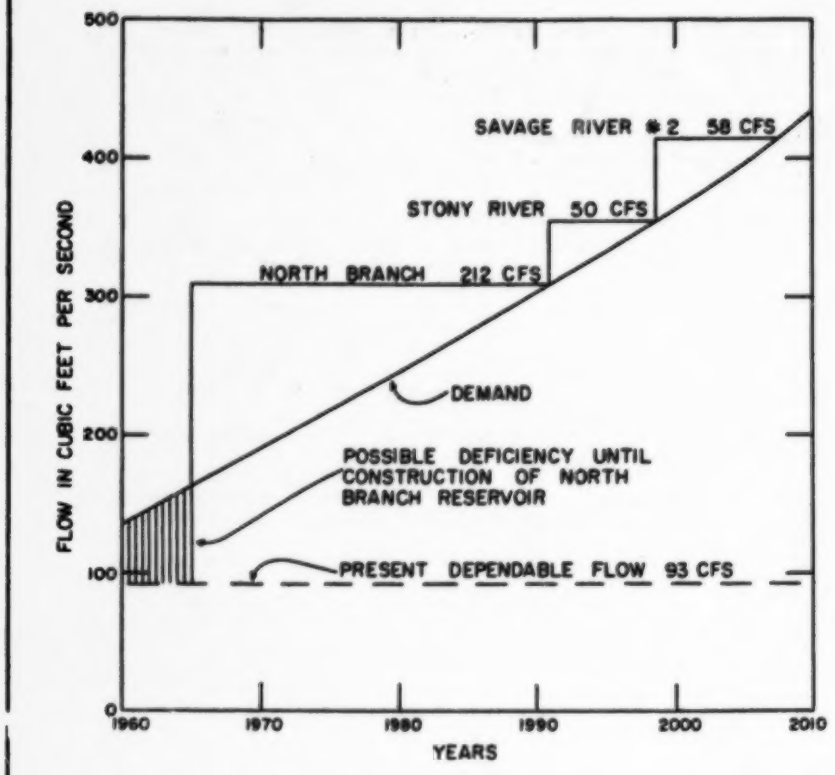
In 1963 the Baltimore District Engineers Report was released. It was a full development plan. The District Engineer recommended 16 major reservoirs on the Potomac (Figure 3), and over 400 "minor" reservoirs, all the size of Little Seneca or thereabouts. Not surprisingly, that plan ran into intense local opposition. There were so many projects, and so many people were against at least one of them, that it was nearly impossible to move toward implementation. The 1963 plan was never submitted to the Congress.

In 1965, in response to a severe drought in the Northeast, a new study, the Northeast Water Supply Study (NEWS), was authorized. In 1965, while the 1963 plan was still under review, President Johnson pledged to swim in the Potomac River and to have the Potomac River serve as a model for the Nation. He kicked the report back to an interdepartmental task force. The Task Force Interim Report in 1966 recommended not 16 reservoirs but three for immediate construction. These were in addition to Bloomington Lake, Little Capapon, Town Creek, and Sideling Hill, all in the vicinity of Paw Paw Bends.

What had happened in the interim was more faith being placed on advanced waste treatment. The 1963 Corps Report (Figure 4) recommended 360 mgd for waste dillution in the Washington Metropolitan Area (WMA). By 1966 there was additional progress in the development of advanced waste treatment. Water for waste dillution was no longer required.

In 1966, there was the drought. The one day low flow of 388 mgd was by far the worst on record. The flow fell below the maximum water supply withdrawal rate for the first time. (That was used as a barometor for years to describe the severity of the Washington water supply crisis.) In 1967, the Washington Suburban Sanitary Commission (WSSC) proposed a weir to backup water for their intakes in times of drought. The COE said no, not until there is a dependable supply for Washington, D.C., a perfectly reasonable argument. The weir was not completed until last year.

In 1968, the COE recommended in testimony before a Congressional Subcommittee the "Six-Pack" of reservoirs. They were the three recommended in 1966 by the Federal Interagency Task Force plus North Mountain, Verona, and Sixes Bridge, with the latter two given top priority.




POTOMAC RIVER REVIEW REPORT

NORTH BRANCH POTOMAC RIVER

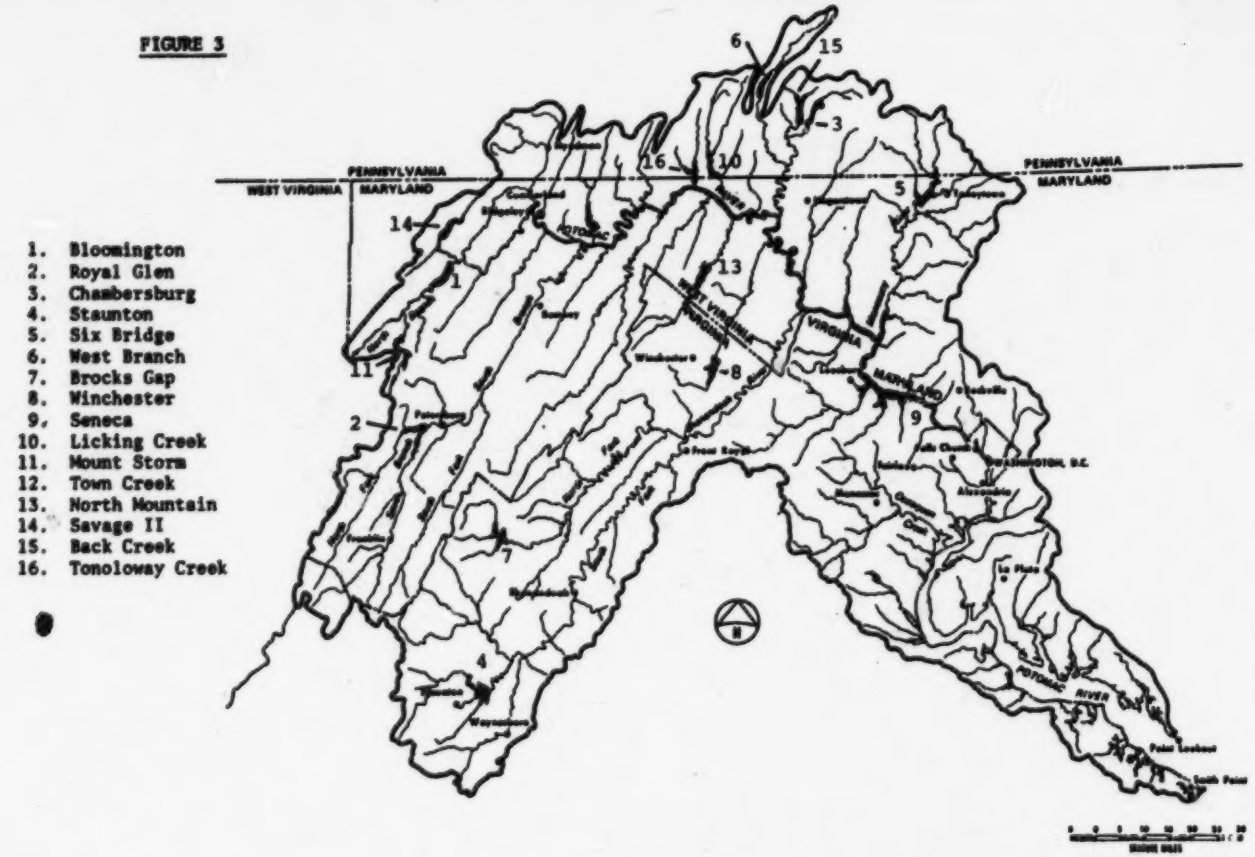
PROJECT SEQUENCING IN RELATION TO WATER DEMANDS

U.S. ARMY ENGINEER DISTRICT WASHINGTON

FEB. 1961 B 410-205.1

FIGURE 2

FIGURE 3




Major Reservoirs in Recommended Plan



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FIGURE 4

Water Supply Needs-2010

Million Gallons Per Day

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In 1969, another unsung hero, Herb Sachs, went to work. He almost single-handly put together the Maryland Potomac Water Authority, the agency which guaranteed the non-Federal share for the Bloomington Lake Project. This allowed Bloomington to proceed. If it weren't for Herb, Bloomington would still be a dream. In fact, during 1969, there was considerable spectulation that he would never succeed.

In 1970, determination of water quality benefits from Federal projects was left to the Environmental Protection Agency (EPA) Administrator. Credit for water quality benefits from low flow augmentation was effectively discontinued. The Secretary of the Army reevaluated the Chief of Engineers Report which contained the 1966 Report, in light of the new interest rate on Federal investments, at that time 4 1/8 percent. The Secretary recommended only Sixes Bridge and Verona for construction. That report was the first to mention limited use of the Potomac Estuary for emergency supply. The Low Flow Allocation Agreement (LFAA) negotiations formally started in 1970.

In 1971, the NEWS report recommended constructing a pilot treatment plant on the Estuary. In 1972, it was authorized. In 1973, the consulting firm, Hydroscience, did a report quantifying the amount of water available from the Estuary during extreme drought. Also in 1973, a Congressional Conference Committee asked for a reformulation of Sixes Bridge and Verona in light of new policies with regard to cost allocations. An interim NEWS report was prepared which stated that Verona and Sixes Bridge were still the best alternatives for the solving of the Nation's Capitol water supply problem. In 1973, the first money was appropriated for Bloomington Lake and construction started.

In 1974, the Water Resources Planning Act authorized Phase I design for Verona and Sixes Bridge. Local opposition to Sixes Bridge caused further authorization to be conditioned upon completion of the Pilot Estuary Water Treatment Plant, the results of yet another WMA water supply study, and finally a review of both studies by the National Academies of Science and Engineering. Also in 1974, an interesting report was completed for the WMA utilities. Black and Veatch, consulting Engineers, studied the feasibility of interconnections between the utilities for finished water distribution system reliability. That report analyzed six major interconnections. In 1974, the Council of Governments (COG) and the COE completed the first draft of the Low Flow Allocation Agreement. In 1974, as a Johns Hopkins University graduate student, I completed a thesis on the Economic Sequencing of Public Works Facilities. This thesis looked at the scheduling of the COE 16 reservoirs. The thesis concluded that by any economic measure, Bloomington Lake is by far the least desirable of the 16 recommended projects. I remember very distinctly arguing with Dr. Able Wolman about this. Dr. Wolman said essentially that reservoir sites don't last, if a reservoir is needed it should be developed. Funny thing about Dr. Wolman, every time I have argued with him I have been wrong.

In 1976, the Interstate Commission on the Potomac River Basin (ICPRP) put together a funding package for a reservoir operations study to be conducted by Johns Hopkins University. At the same time, WSSC sponsored a Bi-County Water Supply Study. In 1976, Congress asked the COE for a Reformulation Report on Sixes Bridge and Verona for WMA water supply. The new study evaluated an interconnection scheme, pumping raw water from the Potomac River to local reservoirs. The Report concluded that interconnections could supply demands through the year 2000. By 1976 everyone was getting pretty frustrated with the failure to get anything done for the MWA water supply situation.

In 1977, work started on the JHU research. It actually started at the USGS, which although not a formal participant in the study, hired the two students who were going to use the research for their dissertations. The two were Jim Smith, who now works for ICPRB, and Rick Palmer who used to work for ICPRB. These two students collected all the raw data. By the time the project started analysis could begin.

In 1977, I was working for COG on 208 water quality management (WQM) planning and came to some surprising conclusions about WMA water supply problems. The question of how much water there would be coming over Little Falls, into the estuary had to be resolved. This was needed for modeling runs for waste load allocations. Since demands on the river equalled the 7-day 10-year low flow, the answer was nothing. Thinking about it, the water coming over Little Falls has some pollutants. If these are routed through the treatment plant, at least some will be removed. If that is true, then maybe the utilities should operate to maximize Potomac River withdrawals all the time. That meant taking as much water from the Potomac River as possible and reducing withdrawals from local reservoirs. Such an operation would save a lot of water in the local reservoirs. How much?

The easiest way to answer that question was to compare demands, flows, and storage as indicated in Tables 1-4. The water in local storage is more than enough to meet demands through the turn of the century. This was, at the time, a startling conclusion.

In 1977, the final NEWS Report came out and dropped the concept of interconnections introduced in 1974. The way in which those interconnections would be operated was too expensive. The NEWS Report was the first report to examine variable operating rules. The Report concluded that while the reservoirs were too far upstream to manage on a daily basis, they could be managed on a monthly basis. NEWS recommended a sliding monthly schedule. This was the first step towards the daily release schedules which are now being proposed.

A drought occurred in the Occoquan River Basin in 1977. This drought was the catalyst for the development of risk analysis techniques for the Occoquan Reservoir. In August, the Occoquan reservoir was being

TABLE 1

Water Demand Projection
Year 2000

NEWS Study Monthly Demands*

| July | August | September | Average Summer |
|---|---|---|---|
| 771 | 755 | 723 | 750 mgd |

MWCOG Demand Projections**

| Annual Average | Max Day |
|---|---|
| 564 | 798 |

* From NEWS Study Report, U.S. Army COE NAD, 11/75 p. 31. Figures for Potomac Demand Corrected by adding back 130 mgd assumed from Patuxent and Occoquan Reservoirs and assuming additional 10 mgd (total of 14 mgd) from Goose Creek and Beaverdam Reservoirs.

** From Linear extrapolation of figures in Impact Assessment: 1980, 1990, 1995 Water Resources Implications of Growth Forecasts, MWCOG, 1976.



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TABLE 2

Drought Flows, Durations and Recurrence Frequencies*

| Drought Duration | Frequency of Recurrence 10 yr. | 20 yr. | 50 yr. |
|---|---|---|---|
| 7 - Day | 541 | 478 | 419 |
| 14 - Day | 575 | 506 | 438 |
| 30 - Day | 641 | 568 | 503 |
| 60 - Day | 729 | 632 | 541 |
| 90 - Day | 813 | 697 | 580 |
| 120 - Day | 929 | 794 | 658 |

* Flows in mgd at Point of Rocks, Maryland.

Source: Walker, Patrick N., Flow Characteristics of Maryland Streams, Maryland Geological Survey, 1971, p. 113.

TABLE 3

Total Water Deficits (billions of gallons, assuming no flow augmentation from Bloomington)

| Drought Duration | Frequency of Recurrence 10 yr. | 20 yr. | 50 yr. |
|---|---|---|---|
| 7 - Day | 1.4 | 1.9 | 2.3 |
| 14 - Day | 2.5 | 3.4 | 4.4 |
| 30 - Day | 3.3 | 5.5 | 7.4 |
| 60 - Day | 1.2 | 7.1 | 12.5 |
| 90 - Day | 0 | 4.8 | 15.3 |
| 120 - Day | 0 | 0 | 11.0 |

TABLE 4

Storage Capacities of
Metropolitan Area Reservoirs

| Reservoir | Storage* |
|---|---|
| Occoquan | 9 |
| Tridelphia | 5 |
| Duckett | 5 |
| Beaverdam (off Goose Creek) | 1 |
| Total | 20 |

* Storage given in billion gallons, rounded down from working storage, and excluding flood control storage in Tridelphia and Duckett.



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rapidly depleted. The people who knew the reservoir were saying that there was an emergency. This conflicted with a consultant's report on the safe yield of the Occoquan. At the end of August, available data indicated a much lower yield than the consultant claimed. There was indeed a serious problem.

Bob Hirsch of the USGS and I discussed this situation and quickly developed a means for quantitatively assessing the problem. Simply, the technique used multiple simulations, each starting with the current reservoir contents, and each using different years of streamflow. At that point, about 20 percent of the simulated years would have resulted in a dry reservoir. An independent technique using historial meteorological data instead of streamflow data was also developed. Both techniques gave similar estimates of the probability of running out of water. Table 5 gives these results as of the end of October in 1977. The probability of getting down to just about the panic level was 13 percent.

This was discussed with the local elected officials. They agreed that the risk was too high. They asked, "How much do we have to reduce demand? A reduction from 40 mgd to 32 mgd would reduce the risk to about 5 percent (Table 6). The local governments proceeded with a compaign to reduce use by 8 mgd. This was the first use of risk analysis in the WMA.

The LFAA was finally signed in 1977 after seven years of negotiation. The Emergency Estuary Pumping Station received its first appropriation. The Bi-County Water Supply Study Task Force adopted a plan calling for occasional restrictions. As far as I know, this was the first time that demand management was included in water supply planning. A Federal-Interstate-State-Regional Advisory Committee (FISRAC) to the COE requested that finished water interconnections be evaluated.

In 1978, the final plan of study for the WMA was completed by the COE. The Congress asked for a reformulation study for Bloomington Lake. The COE contracted with ICPRB for a finished water interconnections study for the WMA. The original concept was that if somehow all the fingers of the distribution systems could be connected, it would be possible to shove water from the reservoirs into the system when needed. Also, water from the Potomac River could supplement reservoir water in the system when Potomac River water was plentiful. After about three months work, that idea was abandoned. Finally an attempt was made to simulate the operations of the systems as they were currently planned, including the Fairfax County Potomac treatment plant, under construction at that time. This increased estimates of system yield by 100 mgd.

In 1978, the Hopkins Study began producing results. Figure 5 shows a potential yield at Washington in excess of 1 bgd given efficient operation. Because it assumes perfect foresight that number is too high. The challenge then, was to design practical

TABLE 5

PROBABILITIES OF FALLING BELOW STORAGE LEVELS
AT 40 MGD (CURRENT PRODUCTION RATE) AT OCCOQUAN*

| Storage Level | 93 feet | 88 feet | 83 feet |
|---|---|---|---|
| Volume of Storage Remaining | 1.7 B.G. | 1.1 B.G. | 0.7 B.G. |
| Probability | 13% | 10% | 8% |

* Purchase of 1.5 B.G. from Lake Manassas is assumed.



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TABLE 6

PROBABILITY OF FALLING BELOW STORAGE LEVELS
AT 32 MGD PRODUCTION AT OCCOQUAN*

| Storage Level | 93 feet | 88 feet | 83 feet |
|---|---|---|---|
| Volume of Storage Remaining | 1.7 B.G. | 1.1 B.G. | 0.7 B.G. |
| Probability | 5% | 3% | 2% |

* Purchase of 1.5 B.G. from Lake Manassas is assumed.



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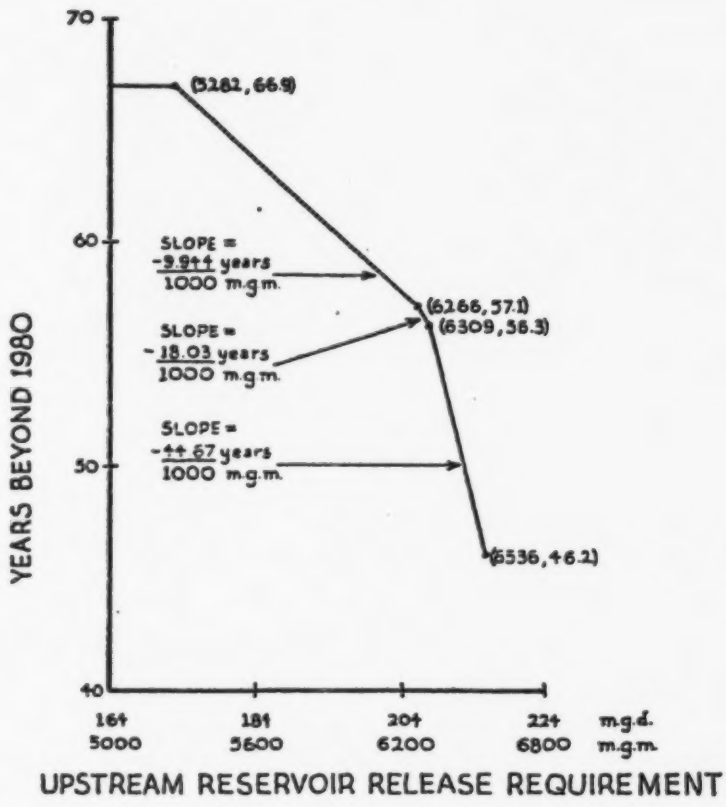
FIGURE 5

## TRADE-OFF CURVE FOR UPSTREAM RESERVOIR RELEASE REQUIREMENT AND SYSTEM YIELD



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rules which would produce yields nearly that large. An interactive simulation model was developed to this end. The simulation, called PRISM, was eventually adopted by the COE and used to develop their recommendations. Most important, a group of people from the utilities sat down and operated the systems using PRISM. A lot was learned by all, concerning what it meant to operate Bloomington Lake a week in advance; the kinds of decisions that have to be made; and the factors to be included in a reasonable operating rule for the whole system to work became apparent.

In 1979, the Bi-County Water Supply Task Force recommended construction of Little Seneca Lake in Montgomery County for water supply as well as recreation. A Water Shortage Emergency Plan, prepared by COG, was adopted by the local jurisdictions. The ICPRB formed CO-OP, Cooperative Water Supply Operations on the Potomac. CO-OP's function is to establish an operations center for coordinated management of all water supplies during drought. Also, the WMA Water Supply Study Progress Report came out. This Progress Report recommended entirely local solutions to the WMA water supply problem. This was based largely on the results of the PRISM model. At a meeting of FISRAC in December of 1979, the WMA utilities decided to form a task force to implement the COE recommendation. The paper by Mr. Robert McGarry will discuss the activities of the Task Force.

So much for history. I'll next describe the methods being developed to manage the WMA water supplies. The benefits of coordinated management are quite large. If all of the facilities for WMA water supply were independently operated the sum of the yield would be about 620 mgd. Joint operations can achieve yields of better than 825 mgd from the same system (Table 7). This is more than a 25 percent increase in yield and about equivalent to the combined yields of the proposed Sixes Bridge and Verona projects. Construction costs for these two reservoirs would be close to a quarter of a billion dollars.

The WMA water supply system is not very complicated. There are two reservoirs upstream, Bloomington Lake and Savage River, which for water supply operational purposes can be considered as one. It takes 4 to 5 days for the effects of upstream releases to be felt in the WMA. There are two reservoirs on the Patuxent, one just upstream of the other. These can also be considered as one. Together they have about 10 billion gallons of storage, and a safe yield of about 35 mgd. A 65 mgd (peak) treatment plant is located on the lower reservoir. That feeds the WSSC distribution system which is also fed by a treatment plant on the Potomac with 240 mgd of capacity. The WSSC system can feed almost the entire system from the Potomac River, except during periods of peak demand. This creates the opportunity to save water in the Patuxent Reservoirs and thus make use of the entire capacity of the Patuxent Treatment Plant when the Potomac River is low.

## TABLE 7

### Independent Yield of WMA Water Supply Sources

| Source | Yield (mgd) |
|---|---|
| Potomac River (1 day low flow, 966) | 388 |
| Occoquan Reservoir | 55 |
| Patuxent Reservoirs | 35 |
| Bloomington Lake | 135 |
| | 613 |

The Occoquan treatment plant has a capacity of 112 mgd. The reservoir holds 10 billion gallons with a safe yield of 55 mgd. The Occoquan can be operated in conjunction with the nearly complete Fairfax County Water Authority (FCWA) intake and treatment plant on the Potomac. The water thus saved can assure 112 mgd of effective yield from that system, about double the safe yield.

Also there is a proposed reservoir on Little Seneca Creek. If built, it would be extremely useful. Simply, it allows flexibility to correct for errors in upstream releases. These errors will be made because the releases must be based on 4 to 5 day flow forecasts.

Short-run operating objectives for the system are:

(1) balance the daily flow and daily demand including the flow-by; and

(2) balance the shortage in the reservoirs.

The second objective is important because loss of any reservoir means a loss in flexibility for the system. In addition, the Occoquan is the only possible source for some portions of the FCWA service area. The long range operating objective is to maintain storage sufficient to assure supply through the worst drought to be reasonably expected.

Operating tools available to meet short-range objectives are:

(1) upstream releases, are made four to five days ahead of time;

(2) flexibility in the local systems to take more or less water from the local reservoirs; and

(3) demand restrictions to reduce the uncertainty in demand.

If peak demand is not met, there will be insufficient pressure somewhere in the system, with attendant health and fire hazards. The only tool available to meet long-range objectives is demand restrictions which reduce the average demand.

Operating problems are as follows:

(1) four to five day travel time from the upstream reservoirs requires basing releases on imprecise flow forecasts;

(2) great uncertainty in forecasting the demand which can fluctuate 20 to 25 percent in any given day, and this makes it difficult to schedule the releases four to five days upstream; and

(3) water quality releases in the North Branch.

The water in Bloomington Lake is quite acid. In order to maintain good quality in the North Branch below Westernport, care is required in manipulating not only the amount but also the acidity of the water released on any given day.

Several analytical tools have been developed to deal with these problems. The USGS has developed a travel time model. It indicates that an effect equal to 40 percent of the water is seen at Washington on the fourth day and 60 percent on the fifth day. CO-OP has developed a crude demand model. The model has analyzed the variance in 10 years of daily water use and soil moisture deficit data. The average demand varies by as much as 10 percent per inch of soil moisture deficit in July. There are strong correlations between demand and soil moisture deficit in July and August, weak correlations in June and September, and essentially no correlation in any other month of the year. This means that in July demand can be 30 percent more in a dry year than in a wet year. The demand models allow estimates in demand to be made for scheduling. These models are in need of more work.

Finally, the National Weather Service (NWS) and CO-OP have developed a flow forecasting model. Development of the predictor has been a major effort of CO-OP. The first cut at a predictor had the flow remain unchanged. By running a simulation and operating the reservoirs through a drought using that predictor, the system yields presented earlier were developed. The NWS predictor, called the River Forecast System is certainly much better.

It will also provide long range predictions which are much more important than the short range. The long range predictions allow for the determination of when there is an unreasonable risk of not meeting long range demand, so that modest demand reductions can still solve the problem. It is these new analytical tools which allow making releases from upstream reservoirs on a daily basis for use downstream. This means these reservoirs are being used in a way the 1974 NEWS study indicated they couldn't be used. NEWS used monthly release schedules. It makes a large difference, especially when you are looking at really short dips in the flow in the river.

The National Weather Service River Forecast System (NWSRFS) is basically a soil moisture accounting model (Figure 6). It takes historical rainfall records and traces water movement through several different storage compartments representing soils in the upper and lower zones. It keeps track of how much is in each one of those reservoirs and how much drains into streams. It does not measure actual groundwater levels. The model is calibrated using historical meterological data. The parameters are adjusted until the model reproduces measured streamflow at USGS gauges. CO-OP has calibrated the model for the entire Potomac.

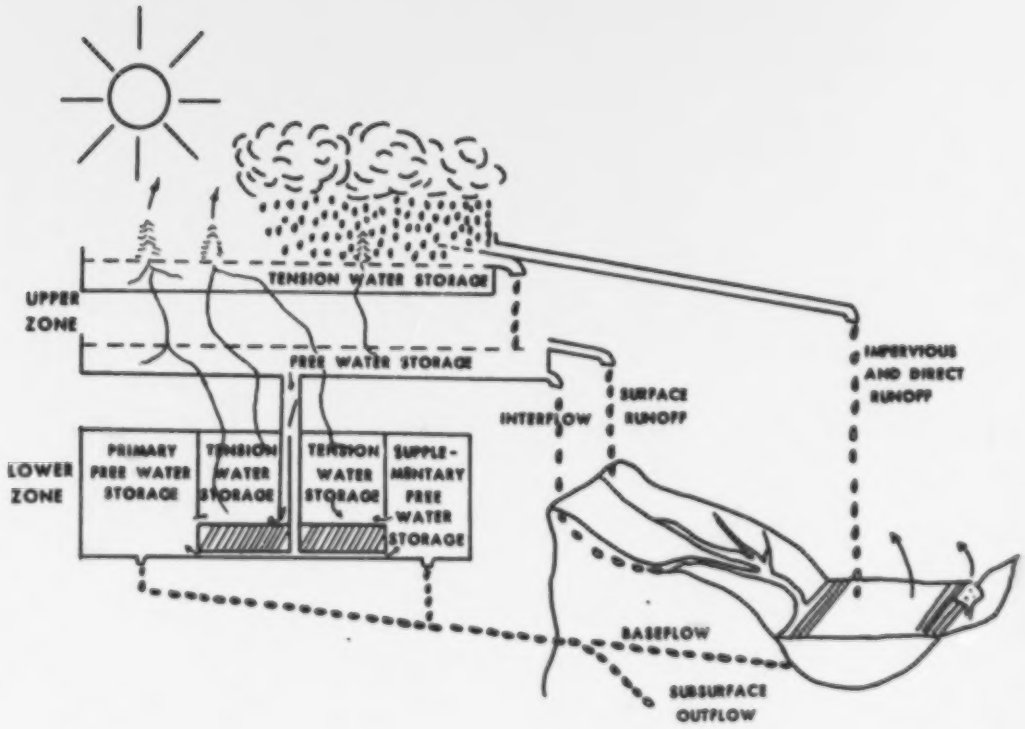


FIGURE 6. --Illustration of a generalized hydrologic model.

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To make long range forecasts, the model is run from the date on which the forecast is to be made, using current soil moisture conditions. This gives conditional streamflow traces. Meteorological records for each of 26 years are used to estimate streamflows which would occur if the weather was to repeat itself. The assumption is that a repeat of any year's rainfall is equally likely.

The amount of water in the ground at the beginning of the summer makes a big difference in the amount of streamflow that can be expected from the river. In May of 1981, the groundwater conditions, except in the North Branch, were as dry as they have ever been. In the Shenandoah, which provides some 40 percent of low flows in the Basin, the flow for May was a record low; only half of the previous record low. The procedure outlined above (called Extended Streamflow Prediction, ESP for short) was used to run the resulting streamflows through a simulation model. The number of days of restrictions, shortages, and the maximum daily shortages that would have occurred with repeats of historical rainfall were counted. There was a substantial probability of restrictions, and some probability that shortages would occur (Table 8).

Forecasts were also made concerning the probability of impounding water in Bloomington Lake if the dam were closed. Figure 7 is a plot of probability versus storage for closing the dam on May 21 or June 1. On May 21 there was a 89 percent chance of getting a billion gallons in storage. On June 1, a week and a half later, there was only a 71 percent probability of achieving the same storage level.

The easiest way to illustrate how coordinated operations works is by example. The utilities and the COE agreed that it might be a good idea if they sat down and tried to operate through a simulated drought. Tables 9 through 11 show the kind of information used to determine daily operations. Long-range forecast information was produced every two weeks. Table 9 is the forecast for September 15. On the evening before each simulated day, the utilities were given a proposed operating sheet (Table 10) which contained a recommended additional upstream release, a predicted river flow, 5-day river flow prediction, predicted demands and recommended withdrawals. On the basis of this information, the utilities began the next day with certain target withdrawals from the Potomac and from the reservoirs. The downstream progress of releases that were made previously from Bloomington and Savage can easily be traced. In the middle of the next day, a revised operating sheet was produced (Table 11). In this case, this revised operation shows a small shortage of water, about 12 million gallons. The shortage occurred because of over-predicted flow and underpredicted demand.

TABLE 8

Potential Consequences of
Historical Droughts for 1981
Washington Metropolitan Area

| | 100 mgd Flowby Over Little Falls | | | |
|---|---|---|---|---|
| | '66 | '65 | '64 | '53 |
| #Days of Restrictions | 51 | 9 | 30 | 42 |
| #Days of Shortages | 6 | 0 | 0* | 0 |
| Max. Daily Shortage/mg | 50 | 0 | 0* | 0 |
| Required Storage/mg** | 1000 | 0 | 1000 | 0 |

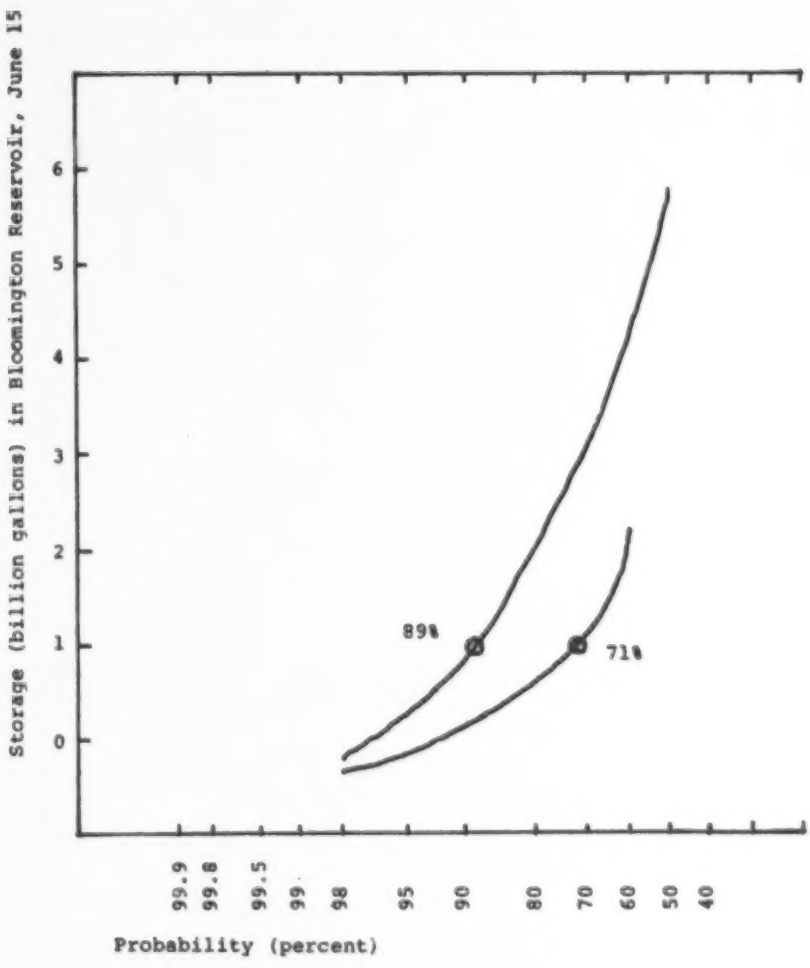
| | 200 mgd Flowby Over Little Falls | | | |
|---|---|---|---|---|
| | '66 | '65 | '64 | '53 |
| #Days of Restrictions | 56 | 40 | 35 | 59 |
| #Days of Shortages | 12 | 0* | 14 | 0* |
| Max. Daily Shortage/mg | 142 | 0* | 95 | 0* |
| Required Storage/mg | 3000 | 500 | 2000 | 1000 |

*Although no shortages would have occurred, the Emergency Stage of the LFAA would likely have been required.

**Storage necessary to avoid Emergency Stage under the LFAA.

FIGURE 7

Probability Plot for Storage in Bloomington *




*Assuming Savage Reservoir is full at both close date and June 15

## TABLE 9

WATER SUPPLY FORECAST FOR SEPTEMBER 15, 1981

POTOMAC RIVER AT LITTLE FALLS:

CURRENT FLOW: 420 (MGD)

MINIMUM FLOW FOR THE PERIOD SEPTEMBER 15 THROUGH NOVEMBER 1

| YEAR | CONDITIONAL MINIMUM FLOW (MGD) | OBSERVED MINIMUM FLOW (MGD) |
|---|---|---|
| 1960 | 974 | 512 |
| 1961 | 873 | 496 |
| 1962 | 760 | 489 |
| 1963 | 582 | 390 |
| 1964 | 483 | 484 |
| 1965 | 838 | 424 |
| 1966 | 1711 | 489 |
| 1967 | 1144 | 426 |
| 1968 | 725 | 375 |
| 1969 | 1143 | 514 |

OCCOQUAN RESERVOIR:

CURRENT STORAGE: _____ (BILLION GALLONS)

| YEAR | TOTAL VOLUME FOR THE PERIOD SEPTEMBER 15 THROUGH NOVEMBER 1 | | TOTAL VOLUME FOR THE PERIOD SEPTEMBER 15 THROUGH JANUARY 1 | |
|---|---|---|---|---|
| | CONDITIONAL TOTAL VOLUME (Bill. Gals.) | OBSERVED TOTAL VOLUME (Bill. Gals.) | CONDITIONAL TOTAL VOLUME (Bill. Gals.) | OBSERVED TOTAL VOLUME (Bill. Gals.) |
| 1960 | 0.8 | 7.8 | 13.4 | 10.7 |
| 1961 | 1.8 | 3.0 | 11.8 | 16.1 |
| 1962 | 0.9 | 0.8 | 13.0 | 11.3 |
| 1963 | 0.7 | 0.7 | 11.6 | 14.7 |
| 1964 | 2.9 | 2.6 | 9.0 | 12.5 |
| 1965 | 1.0 | 1.5 | 1.5 | 2.4 |
| 1966 | 4.7 | 25.4 | 46.5 | 37.0 |
| 1967 | 1.2 | 2.1 | 16.2 | 29.1 |
| 1968 | 0.5 | 0.7 | 9.6 | 10.5 |
| 1969 | 1.4 | 4.6 | 17.5 | 24.9 |

PATUXENT RESERVOIRS:

CURRENT STORAGE: _____ (BILLION GALLONS)

| YEAR | TOTAL VOLUME FOR THE PERIOD SEPTEMBER 15 THROUGH NOVEMBER 1 | | TOTAL VOLUME FOR THE PERIOD SEPTEMBER 15 THROUGH JANUARY 1 | |
|---|---|---|---|---|
| | CONDITIONAL TOTAL VOLUME (Bill. Gals.) | OBSERVED TOTAL VOLUME (Bill. Gals.) | CONDITIONAL TOTAL VOLUME (Bill. Gals.) | OBSERVED TOTAL VOLUME (Bill. Gals.) |
| 1960 | 0.7 | 2.4 | 3.2 | 4.7 |
| 1961 | 1.1 | 1.3 | 2.8 | 3.6 |
| 1962 | 0.8 | 0.9 | 4.5 | 3.3 |
| 1963 | 0.7 | 0.8 | 2.9 | 4.2 |
| 1964 | 0.8 | 1.0 | 4.1 | 3.7 |
| 1965 | 1.2 | 1.2 | 2.3 | 2.5 |
| 1966 | 1.8 | 4.6 | 10.8 | 7.8 |
| 1967 | 2.1 | 2.5 | 4.4 | 7.7 |
| 1968 | 1.3 | 2.2 | 4.9 | 6.5 |
| 1969 | 0.6 | 2.3 | 2.8 | 5.8 |



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**TABLE 10**

DAY #: 23
WEEK #: 4

PROPOSED OPERATING SHEET FOR TOMORROW = 9/23

428. =PRED. NATURAL FLOW + SAVAGE WQ RELEASE
0. = EFFECT OF ADDITIONAL SAVAGE RELEASES
---
428. = PREDICTED RIVER FLOW TOMORROW

511. = 5 DAY RIVER FLOW PREDICTION (INCLUDES REC. SUPPL. REL.)

1.252 = PRED. DEMAND/FLOW RATIO
1.000 = PRED. 5 DAY DEM./FLOW RATIO

3474. = SAVAGE STORAGE
44. = SAVAGE WQ RELEASE

99. = ******* RECOMMENDED ADDITIONAL SAV. REL.

| | PRED. DEMAND | MAX. RES. WITHD. | LF ALLOCATION ALLOC | SP/SHT. | RECOM. WITHD. POT. | RES. | SHORTAGE | STORAGES |
|---|---|---|---|---|---|---|---|---|
| WSSC | 148. | 45. | 124. | 21. | 122. | 26. | 0. | 8740.0 |
| WAD/COE | 191. | 0. | 204. | 13. | 191. | | 0. | |
| FCWA | 72. | 112. | 0. | 40. | 15. | 57. | 0. | 5641.9 |
| TOTAL | 411. | 157. | 328. | 74. | 328. | 83. | 0. | |

PREDICTED FLOWBY : 100.
PREDICTED DEMAND REDUCTION FACTORS (WSSC,WAD,FCWA): .15 .15 .05
PREVIOUS SUPPLEMENTAL RELEASES
0. 0. 0. 0. 25. 25.
6 DAYS PREV ---------- YESTERDAY

** MANDATORY RESTRICTIONS WILL BE IN EFFECT ***

PLEASE MAKE ANY PRESS RELEASES AND COMMUNICATE
CHANGES IN EXPECTED % DEMAND REUCTION TO WAD AND ICPRB
ALSO INDICATE HOW LARGE (OR 0.) ADDITIONAL SAVAGE RELEASE
IS DESIRED.
THIS SHEET CAN BE REVISED TO REFLECT THESE CHANGES IF YOU WISH



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**TABLE 11**

REVISED OPERATING SHEET FOR TODAY = 9/23

DAY #: 23
WEEK #: 4

424. = NATURAL FLOW + SAVAGE WQ RELEASE
0. = EFFECT OF ADDITIONAL SAVAGE RELEASES
---
424. = TOTAL RIVER FLOW

| | ACT. DEMAND | MAX.RES.WITHD. | LF ALLOCATION ALLOC | SP/SHT. | RECOM.WITHD. POT. | RES. | SHORTAGE | STORAGES |
|---|---|---|---|---|---|---|---|---|
| WSSC | 149. | 45. | 122. | 18. | 104. | 45. | 1. | 8740.0 |
| WAD/COC | 221. | 0. | 202. | -19. | 220. | | 1. | |
| FCWA | 71. | 112. | 0. | 41. | 0. | 71. | 0. | 5641.9 |
| TOTAL | 442. | 157. | 324. | 39. | 326. | 116. | 2. | |

TODAYS SUPPLEMENTAL SAVAGE RELEASE IS : 0.

WITH RECOMENDED ALLOCATION, FLOWBY WILL BE : 100.

REVISE PATUXENT, OCCOQUAN AND POTOMAC WITHDRAWALS AS REQUIRED
PLEASE COMMUNICATE CHANGES TO WAD AND ICPRB

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The drought rehearsal was quite successful. It showed rather conclusively that daily operation of the upstream reservoirs was possible and that the local utilities could effectively coordinate their operations. Moreover it pointed out some flaws in the proposed operations and forced corrections before an actual drought occurred. It showed dramatically which tools (e.g., demand prediction model) were most in need of improvement.

The "operations center" of CO-OP will be fully functional in April 1982. Contracts necessary to implement the results of CO-OP's technical work are under development by the WMA Water Supply Task Force.

CO-OP will continue to refine and improve its operational tools. Besides demand forecasting, CO-OP is working on such ideas as joint operation of the flood control and water supply shortage in Bloomington Lake. Such operation can take full advantage of information produced by NWSRFS about the watershed behind the reservoir. If the soil is dry and will absorb up to an inch and one half of water, less empty storage for flood control is needed, and thus additional storage can be made available for water supply. If the soil is wet and long term runoff is thus assured, more flood storage can be made available without risk of water supply shortage.

This paper has chronicled the history of the search for solutions to the WMA water supply problem since the early 1950's. A tremendous amount of effort, particuarly by the COE, has produced an excellent base for decisions. Because of recent advances in hydrology and stream flow forecasting, long term solutions involving minimal additional construction are now at hand. I firmly believe that the WMA has one less problem to worry about.

# METROPOLITAN AREA WATER SUPPLY EMERGENCY PLAN

by

Austan S. Librach

Mr. Librach's paper was not received for publication.

# THE WASHINGTON METROPOLITAN WATER SUPPLY TASK FORCE

by

Robert S. McGarry

For more years than most of us who are responsible for the Washington Metropolitan Region's water supply care to remember, we have been trying to insure that the communities we serve will have an adequate supply. It should be emphasized that we are not committed to providing all the water needed for all the possible lawn watering during the most severe drought on the driest day thereof. All our planning today is based on conservation and drought management through restrictions as necessary. We prefer to avoid restrictions but accept that they, along with conservation, are elements of water resource planning.

The history of efforts has bearing on formation of the Washington Metropolitan Water Supply Task Force so it is appropriate to review the past briefly.

## THE PAST

| | |
|---|---|
| 1962 | Bloomington Lake authorized |
| 1963 | Corps' District Engineer recommends 16 Reservoirs |
| 1969 | Chief of Engineers recommends 6 of the 16 |
| 1970 | Secretary of the Army recommends 2 of the 6:<br>Sixes Bridge - Maryland<br>Verona - Virginia |
| 1974 | Congress authorizes:<br>Sixes Bridge - Maryland<br>Verona - Virginia<br>Pilot Estuary Plant<br>A new final all purpose Washington Metropolitan Water Supply Study |

The Bloomington Lake that started filling in the summer of 1981 was authorized in 1962 (almost 20 years from the time it was authorized until it was in service). Almost in conjunction with the authorization of Bloomington, the Baltimore District Engineer completed a Potomac water resource study and recommended 16 reservoirs in the basin. This sounds like a large number of reservoirs, and it is, but it should be remembered that the study considered flood control and pollution abatement as well as water supply. Six years later the Chief Engineers, after reviewing the report, recommended that six of the sixteen be constructed immediately. The Secretary of the Army reviewing the Chief's recommendation a year later recommended two of the six - Sixes Bridge and Verona - for early action. Four years later, in 1974, the Congress not only authorized Sixes Bridge and Verona, they authorized Pilot Estuary Plant and yet another study of the Washington Metropolitan water supply. This study is unique because it was authorized by Congress without the request of local jurisdictions and also unique because the authorization requires a review by the National Academy of Sciences/National Academy of Engineering.

What has happened to all this Congressional activity in 1974?

In the Fall of 1981, Bloomington Lake was completed and is in operation. The Pilot Estuary Plant was completed and is in the testing phase. Because of local opinion both Sixes Bridge Reservoir in Maryland, and Verona Reservoir in Virginia are, for all practical purposes, a dead idea. The Corps has completed the interm report on the Metropolitan Washington Area Water Supply Study. As will be explained, this interim report had a significant impact on the water supply issue.

Perhaps the most important step taken since 1974 was the formation of a Regional Water Supply Task Force to solve the region's problems with regional resources. Water supply is a local problem and we have finally recognized the problem as our responsibility and put in place a mechanism to resolve it.

A brief review of the events that lead to the formation of the Water Supply Task Force is also important. Frustrated with years of study that produced no action to resolve Prince George's and Montgomery Counties' water supply situation, the two Maryland counties determined to find a solution that could be implemented by Washington Suburban Sanitary Commission (WSSC) for them. In 1975, Prince George's, Montgomery County and WSSC formed a Bi-County Water Supply Task Force. It is important to consider how this Task Force operated because it was successful. First, the Task Force was the political leadership of the two counties. Since the solution would have to be approved and financed by the local governments through the WSSC and if opposition arose it would be the political leadership that took the heat, it was very important that elected

officials lead the Task Force. The Task Force also had a strong Citizens Advisory Committee that did their homework, studied the issues, and influenced all decisions. This citizen involvement was important because the conclusions of the study were liable to be controversial. A broad based citizens' committee with expertise and interest in the environment and welfare of the two counties would assist the political leadership to obtain public support for any final decisions. Third, the Task Force had strong technical support from WSSC and consultants selected in consultation with the leaders and the Citizens Advisory Committee. After two years, the Task Force completed their work and first accepted the concept of risk (drought) management. An over simplification of almost two years of work describes the risk management concept. The Task Force accepted an 8 percent probability that there will be restrictions on the outside use of water (primarily lawn irrigation) in any year. This reduced the additional water requirements by almost two thirds. Having accepted this fairly new concept of drought management, the Task Force considered 13 alternative ways to meet the bi-county demands and selected the construction of Little Seneca Reservoir. Several public hearings on the Task Force's work showed general support for the analysis and Little Seneca as the best solution. This facility is well on its way to construction. All land has been purchased, the design is complete and the necessary State and Federal permits have been issued. Little Seneca Reservoir, plus WSSC's share of Bloomington Lake, will insure that Montgomery and Prince George's County have an adequate water supply through 1995. The Maryland portion of the regional water supply problem was solved!

While the Bi-County Water Supply Task Force was making their study the Corps' Metropolitan Washington Study was also underway. At the request of local governments the Corps' interim report concentrated on solutions that could be implemented within the region served (as opposed to reservoirs in other counties or even other states). Again, it is an over simplification to try to summarize such a thorough study so briefly, but the Corps concluded that the water supply needs of the metropolitan region could be met using WSSC's Little Seneca plus an interconection between either the Occoquan or the Patuxent Reservoirs and the Potomac River. The study also pointed out that these were local decisions.

As part of the Corps' interaction with local and state agencies, the District Engineer established a Federal, State, Interstate, Regional Advisory Committee for the study (FISRAC). At the FISRAC meeting in the Fall of 1979, all members concluded that the solution was indeed local. The Corps' recommendations could be implemented if the local governments and water supply agencies chose to do so. The FISRAC members also concluded that the success of the Bi-County Water Supply Task Force suggested a Washington Metropolitan Water Supply Task Force be formed to solve this problem and asked to see if such a Task Force could be organized.

In January 1980, the Presidents of the District of Columbia, Fairfax, Prince George's and Montgomery Councils met at WSSC and agreed to form such a Task Force. This was a major step forward. The four regional governments had met and agreed to solve their water supply needs regionally. Because of the success of the Bi-County Water Supply Task Force, the D.C. Metro Task Force was organized the same way. The Task Force consists of the President (or Chairman) of the four Councils. A strong Citizens Advisory Committee of 12 (three from each jurisdiction) has been formed and they have been involved in each step of the study and decision-making process. The technical committee, using the resources of the Washington Aqueduct Division (WAD), the Fairfax County Water Authority (FCWA) and WSSC, has provided the data and analysis for the Task Force's consideration.

Shortly after the first meeting the Task Force approved the following work plan:

(1) Demand - The first step of the Task Force would be to analyze all available data and previous studies to determine the demand for the region;

(2) Existing Capacity - Next a study of the existing capacity of all the regional facilities including Bloomington and WSSC's planned Little Seneca Reservoir;

(3) Options to meet Shortages - Expecting that existing capacity would not meet the demand, the Task Force would then consider a range of options to meet any shortages;

(4) Public Workshop - At this point the Task Force planned a public workshop to obtain public understanding and hopefully concurrence on the demand, existing capacity and the options to meet the demands;

(5) Action Plans - The options would be analyzed and a plan selected;

(6) Public Hearings - A series of public hearings in the four jurisdictions to explain the adopted plan and receive public input; and

(7) Select Action Plan - Following public hearings and after consideration of the input the Task Force would select a plan for information.

For the regional water needs it was decided to use the Corp's Metropolitan Washington Water Supply data. There was some consideration that changes in population projections since the Corps' study might have caused a significant change in demand. However, it was found that this was not the case and the Corps' projections were accepted.

The Task Force next turned to the analysis of existing capacity. During the period the task force was beginning its work another important regional decision was made. At the recommendation of the Interstate Commission on the Potomac River Basin (ICPRB), it was agreed to form the CO-OP Section. The purpose of this section was to develop a computer water supply operating model that would enable the region to more accurately forecast river flows and predict demand and thereby manage supply better. It is important to note that the CO-OP Section and model are regional in nature. In analyzing the capacity the task force decided to use this model. In conjunction with the ICPRB, we developed the model to predict daily demands based on the Corps' analysis of regional demand, predict daily flows, and then simulate releases from all reservoirs. Again, the nature of this model is extremely important because all facilities; Fairfax County's Occoquan Reservoir, WSSC's two Patuxent Reservoirs, the Savage Reservoir in Allegheny County, the newly completed Bloomington Lake and WSSC's proposed Little Seneca Reservoir (which at that time was intended solely for the use of Prince George's and Montgomery County) are included as regional resources.

The Technical Committee (WSSC, WAD and FCWA) in conjunction with the Director of ICPRB CO-OP found that the region had adequate water through the year 2000 if:

. ALL the facilities were operated on a regional basis;

. The CO-OP model logic analysis was sound; and

. The legal, financial and political implications of regional cooperation could be solved.

We studied the model's logic further, discussed it with experts from the Corps, and concluded that the logic was indeed sound.

After thorough coordination with the Citizens Advisory Committee, it was recommended to the Task Force that the regional water supply needs (through 2000) could be met if the entire regional

capacity was operated regionally and if Little Seneca Reservoir was shared. The Task Force approved this concept and directed the Technical Advisory Group and the citizens to develop recommendations on cost sharing and regional operating agreements. This is indeed a significant point in the water supply situation for the District of Columbia and Metropolitan region. A solution acceptable to all the jurisdictions, implementable within the jurisdictions, had been agreed upon. Only the details of implementation remain to be resolved.

The remaining work for the Task Force is the cost-sharing arrangements and a regional operating plan. Also, it may be necessary to modify the Potomac River Low Flow Agreement. Side issues that have to be resolved are the inter-relationship of the Potomac Water Authority and the regional jurisdictions in regard to repayment to the Federal Government for the water supply storage in Bloomington Lake and the question of the operating and maintenance costs for Savage Reservoir which are currently borne by Allegheny County.

Extensive negotiations among the water suppliers in the region have been conducted during the Spring, Summer and Fall of 1981 and we are prepared to recommend to the Task Force the cost-sharing arrangements below:

(1) That FCWA, WSSC and WAD purchase all the water supply storage in Bloomington Lake. We do not feel that the counties and users upstream of the Metropolitan region need to share in the cost of Bloomington because they are non-consumptive users;

(2) That WSSC pay 50 percent, the WAD pay 30 percent and FCWA pay 20 percent of the costs of Bloomington Lake. The Citizens Advisory Committee has reveiwed these recommendations and concurs;

(3) That Fairfax County, Prince George's County, Montgomery County, District of Columbia and Allegheny County share the O&M costs for Savage Reservoir five ways. The Savage Reservoir will be used primarily to dilute the acidic releases from Bloomington and therefore is an integral part of water supply for the region and cost-sharing is approriate;

(4) That FCWA, WSSC and WAD share the costs of Little Seneca Reservoir and that the reservoir be part of the regional water supply; and

(5) Our recommendation is that FCWA pay 10 percent, WSSC pay 50 percent and the WAD pay 40 percent. Again, the citizens committee concurs.

The regional operating plan will, in essence, be a document that incorporates the principles and logic of the CO-OP water supply model into an agreement to be signed by the three supply agencies. The model is programmed to direct releases from various reservoirs, giving due consideration to predicted demand, predicted river flows,

reservoir status and the 4 to 7 day travel time of releases from Bloomington Lake to insure an adequate supply of water. As stated earlier, we have satisfied ourselves that the concept of the model is accurate and sound. Since a computer program is not a very good vehicle for an agreement we must incorporate the principles of the model into a document that can be signed. This should not be difficult.

The Technical Group has identified a part of the Low Flow Allocation Agreement that must be resolved. The Low Flow Allocation Agreement freezes the percentage allocated to each user after 1988 unless the parties agree to change. While we are very confident that the Low Flow Allocation Agreement will never be needed if the system is operated regionally and if Little Seneca is available, there does remain the possibility of a drought two to three times more severe than any drought in the past. The Low Flow Allocation Agreement, which allocates river flows during shortages would then be invoked. The Technical Group is still pondering whether the so-called "freeze" is still appropriate under a regionally operated system wherein the costs of all water shortage are shared and the regional facilities are operated to meet everyone's needs. We expect to complete our work and coordinate it with the Citizens Advisory Group in early January 1982. We will then submit our recommendations to the Task Force and with their approval proceed with the construction of Little Seneca Reservoir and a solution to the water supply problem that has been plaguing the District of Columbia and the Metropolitan Region for more than twenty years.

Water supply is a regional and/or local problem. While we appreciate the significant assistance of the Federal Government through the Corps of Engineers in resolving this problem, we recognize our responsibility and are on the threshold of solving this matter once and for all.

## BIOGRAPHICAL DATA ON SPEAKERS

Gilbert Gude, is Director of the Congressional Research Service of the Library of Congress, from 1967-1976 he served as a Member of the U.S. House of Representatives from Maryland. Mr. Gude was key sponsor of bills creating the C&O Canal National Historical Park; his legislative work emphasized metropolitan regional affairs and open space and parks, and proposals to establish a Potomac National River.

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